science to support sustainability

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BRITISH COLUMBIA
Ministry of Forests

Forest Science Program Mission Statement

To help provide innovative solutions to high-priority forest management problems in B.C. and to advance resource stewardship based on scientific principles.

Message from the Chief Forester and the Assistant Deputy Minister, Operations 1

Message from the Director 2

Overview of the Forest Science Program

Science to Support Strategic Priorities 3
Program Priorities 3
Organization 4
Clients and Partners 4
Funding and Expenditures 5
Funding Trends and Initiatives 5

Feature

More Than a Quarter Century of Ecological Classification 6

The Forest Science Program in 2001/02

Silviculture 15
Growth and Yield 21
Ecology 25
Earth Sciences 32
Forest Genetics 38
Research Support 41

Forest Science Program Publications, April 1, 2001 to March 31, 2002 47

Biogeoclimatic Ecosystem Classification Definitions 53

How to Contact Us 54

Figures

Figure 1: Forest Science Program Expenditures 1998 – 2002 4
Figure 2: Forest Science Program Funding 2001/02 5
Figure 3: Levels of Integration in the Classification System 7

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A new provincial government administration took office in June 2001 with a mandate for change and renewal, which was reflected in more than 200 specific commitments. These include initiatives to enhance sustainable forestry and environmental stewardship, while revitalizing the economy and ensuring sound fiscal management.

A government-wide core review process was undertaken in summer and fall 2001 to assess the need and rationale for the delivery of all public-sector functions in B.C., and to explore possible options for alternate delivery of various government services. Later in the year, each provincial ministry undertook a budget process to rationalize its mandate, business model, and organizational structure using 35% fewer resources over the next three years. The Ministry of Forests is now being comprehensively reorganized to enable it to implement major changes in how it conducts its business and delivers services.

The forest science function within the Ministry of Forests will be reduced and refocused to support core business needs and ministry priorities. Government has made a New Era *commitment to environmental stewardship, under which it wants to achieve a scientifically based, principled approach to environmental management that ensures sustainability, accountability and responsibility. We expect our in-house scientific resources to play a continuing and important role in supporting resource stewardship planning and decision-making in the Ministry of Forests, to help achieve that commitment.*

Larry Pedersen
Chief Forester
Assistant Deputy Minister, Forestry Division

Doug Konkin
Assistant Deputy Minister, Operations Division

Significant changes are unfolding for the B.C. forest sector, the Ministry of Forests, and the Forest Science Program. Policy changes and base budget reductions will mean significant shifts in traditional ministry service delivery, in favour of a greater private-sector role in a more streamlined approach to forest resource management. Accordingly, there will also be changes to how and what forest science services are provided by ministry staff.

It is clear that government supports the principle of science-based resource management policies and standards. Special funding provisions for forest research have been made in the new Forest Investment Account. The internal core review process in the ministry identified the need for a continuing in-house forest science function to support policy and standards development, policy-effectiveness evaluation, compliance and enforcement, and statutory decision-making.

However, budget reductions within the ministry have made it necessary to shift resources to core business needs and priorities and to transitional planning for the more discretionary activities. The ministry anticipates making changes in forest policy that will encourage industry to assess the services and information it needs (including research) to meet its increased forest management responsibilities. In forest sciences, the ministry's base-funded role will increasingly focus on protecting the public interest, as opposed to facilitating investment decisions to improve forest productivity and value.

It will be challenging to determine precisely which services are "core" and which are "discretionary." So will be the pursuit of alternative delivery mechanisms as forest policy changes evolve. The Forest Science Program has valuable intellectual and information assets, and transition planning will be crucial to ensure that public investments are safeguarded. At the same time, we will be expected to step up to new responsibilities, such as effectiveness evaluation for the new Forest Practices Code, and support for compliance and enforcement, and State of the Forests reporting.

Overall funding for research during 2001/02 remained at approximately the same level as in the previous two years. Branch and regional Forest Science Program staff worked diligently to deliver Forest Renewal BC research contract work and other service commitments. Since our project portfolio tends to emphasize longer-term, integrated forest practices research initiatives and tree improvement, continuity with the new Forest Investment Account will be important. Our emphasis on balancing longer-term research with short-term problem-solving and consulting has also brought more research staff into the front lines of forest policy evolution. This has provided new opportunities for staff and recognition for the talent in the program. We look forward to expanding these activities and making significant contributions to policy development in the future.

Henry Benskin
Director, Research Branch

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Science to Support Strategic Priorities

The Ministry of Forests manages and protects British Columbia's timber, range and outdoor recreation resources to achieve the best balance of short- and long-term economic, social and environmental benefits for all residents of the province.

The Forest Science Program contributes directly and indirectly to the ministry's work in a number of important ways:

- It expands the knowledge base for the production, sustainable management, and administration of timber supplies.
- It increases our understanding of how integrated management prescriptions can be achieved.
- It refines models and analytical procedures that improve site productivity estimates and growth and yield projections, and predict the implications of different management options.
- It reveals new ways, through work in forest genetics and silviculture, to achieve higher productivity in future stands.
- It expands the scientific foundation for responding to forest practice issues related to hydrology, soils, terrain stability, and ecosystem and stand management.
- It helps with the evolution of *Forest Practices Code of British Columbia Act* code standards, and in the development of training packages.
- It provides essential support for the chief forester in the Timber Supply Review process and decisions.
- It contributes to the development and ongoing refinement of a variety of resource management policies, procedures, and land-use decisions.

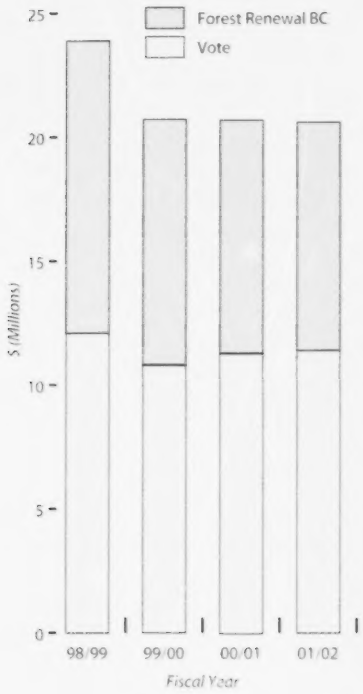
Program Priorities

In B.C., research in the forest sciences is coordinated and guided by a number of committees, advisory boards, councils and partnerships. The Forest Science Board and various client advisory groups are the most significant in integrating external and internal requests for services, and in guiding the priorities and direction of the Forest Science Program.

The Forest Science Board is an internal, inter-divisional body that reviews the annual plans and performance of the Forest Science Program. It then makes recommendations about program priorities. The director of the Research Branch provides Forest Science Program leadership at the provincial level and presents both branch and regional forest science accomplishments to the board.

Regional Forest Science Advisory Groups set priorities and provide direction for regional operations. The headquarters advisory process is delivered informally,

Figure 1: Forest Science Program Expenditures 1998 – 2002



through an ongoing working relationship between Research Branch managers and client managers in other branches.

The Forest Science Program is collaborative in nature. The program includes the Research Branch, within Forestry Division, and six regional Forest Science Teams within Operations Division. Operations and support staff in regional and district offices, other branches of the ministry, and external partners all contribute to the work of the program.

Research Branch researchers work closely with policy-makers and the ministry executive in Victoria to provide a credible science contribution to policy development. Together with regional researchers, they undertake practical research and provide technical support to regional and district operations staff to help them resolve complex operational issues associated with Forest Practices Code interpretation and implementation, silviculture, growth and yield, and timber supply. Regional scientists also advise on emerging front-line issues, often in partnership with the Research Branch, licensees, universities, the Canadian Forest Service, and others.

The Forest Science Program serves a mix of internal and external clients. The majority of (and highest-priority) clients are internal: the ministry executive and senior management, professional and technical specialists, and operational staff at all levels. External clients include other ministries, licensees, other research organizations, public agencies, private industry, and the public.

To meet the program mandate of supporting ministry priorities, Forest Science Program staff meet both client requests for short-term problem solving and advisory services, and the ministry's corporate needs in anticipating and addressing emerging issues and opportunities through research. The program therefore responds to a broad range of client demands, from providing information and technical advice, to designing and implementing complex research projects.

Research activities are also supported by the formation of scientific partnerships and external funding. The Ministry of Forests is a major partner in the Forest Research Extension Partnership (FORREX, at www.forrex.org) (formerly known as the Southern Interior Forest Extension and Research Partnership) and the Northern Forest Research and Extension Partnership. Both organizations are working to incorporate research results into operational practice, improve information sharing, and build cooperation among research organizations and the resource management community. Partners come from government agencies, industry associations, natural resource companies, First Nations groups, non-governmental organizations, Forest Renewal BC, and colleges and universities.

Funding and Expenditures

Forest Science Program expenditures in 2001/02 increased slightly over the previous year, at $21.3 million. As Figure 1 shows, funding for the program came from both internal vote funds (54%) and external sources, mostly Forest Renewal BC (46%).

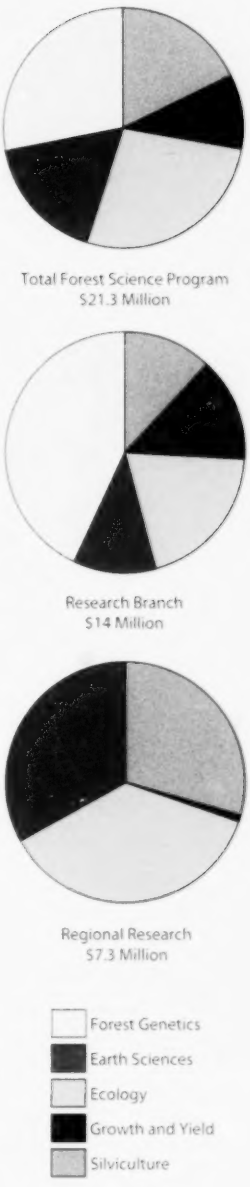
Ministry-voted funding covered mainly essential fixed costs (i.e., most staff salaries, facilities maintenance, and a minimal amount of operating costs); Forest Renewal BC funding provided more than 80% of the overall operating funding for the program.

The provincial Forest Science Program supported the equivalent of 187 full-time positions in 2001/02, split among regional offices (30%), Research Branch headquarters (43%), and Research Branch decentralized facilities (27%). Thirty-three of those positions were funded by Forest Renewal BC.

The division of expenditures across the major activity areas remained about the same as it was in 2000/01: regional resources were concentrated on local operational issues, such as ecosystem management, watershed management and terrain stability, and demonstration and testing of silvicultural systems. Research Branch expenditures went to programs that are more provincial in scope, such as growth and yield, forest genetics, and tree improvement, as well as supporting policy development for ecology, silviculture, and earth sciences.

Research and development work is also conducted by other sections of the Ministry of Forests (e.g., by Forest Practices Branch, among others). Details of those expenditures and accomplishments are not included in this report.

Figure 2: Forest Science Program Funding 2001/02



Funding Trends and Initiatives

In 2002/03, Forest Renewal BC funding will be replaced by the Forest Investment Account (FIA), a new provincial government initiative for promoting sustainable forest management in B.C. Specific amounts have been dedicated to program elements at the provincial level, one of which is a research component. An allocation will be made to the Forest Science Program to continue research projects that had been technically reviewed and approved for Forest Renewal BC funding in 2001/02.

In addition, FIA funding was provided to Forestry Innovation Investment (FII), which funds approved, peer-reviewed research proposals submitted by the forest research community. The Forest Science Program has submitted 23 proposals to FII for funding in 2002/03.

The program is expected to receive fewer funds from all sources in 2002/03 than in previous years, which will result in a reduction in both operating funds and personnel. Over the next two years, the Forest Science Program will be reviewing all elements of its work to ensure that emphasis is concentrated on the scientific services that are most important for the ministry to successfully fulfill its stewardship role.

More Than a Quarter Century of Ecological Classification

Introduction

Early timber harvesting in British Columbia was done in accessible, fertile valley bottom-lands, primarily on the coast and along major access routes in the southern interior. When the B.C. forest industry entered a period of massive change in the early 1960s, new markets for previously undesirable species, such as lodgepole pine and western hemlock, created the potential for timber harvesting in vast untouched parts of the province. Improved logging and hauling equipment and relatively low fuel costs meant that harvest operations could cover greater distances on steeper, more rugged terrain. Just as importantly, the value of residual fibre was pushed up by a growing world demand for high-quality pulp, leading to more complete utilization of wood fibre in harvested areas and at sawmills.

As the industry evolved, so did demands on knowledge about forest management. Managers soon had to cope with new species and site conditions, frequently without any previous experience to guide their decisions. Understandably, errors were made. Some sites were degraded during harvesting, or through the wide application of slash-burning on steep terrain and sensitive soils. Reforestation was difficult on some sites, and on others, inappropriate species were established. For example, Douglas-fir, valued for its growth traits and wood quality, was planted well beyond its natural range. Consequently, by the early 1970s, resource managers began to notice that plantations of Douglas-fir trees were dying – a signal that all was not well in B.C.'s forests.

Evolution of the Biogeoclimatic Ecosystem Classification (BEC) Program

It was evident that resolving such forest management problems would not be an easy task. Not only would it be necessary to develop appropriate prescriptions for a wider variety of site conditions, but forest managers also needed to know where and when to apply them. But how could a manager understand a site well enough to know which management prescription to apply? Ecologists and other researchers played significant roles in developing this new knowledge.

New research findings showed that the composition of naturally occurring plant species varied according to certain soil, climate and land form combinations. This

seed of a classification concept was nurtured by Professor Vladimir Krajina and his students at the University of British Columbia (UBC) over a 25-year period, from 1950 to 1975. They proposed that a variety of ecological zones could be identified throughout B.C. based on their biogeoclimatic characteristics. As resource managers in the provincial Forest Service and the industry became aware of these studies, they saw the potential of such a classification system. Rather than each forest site requiring a unique management treatment, it could be viewed as a member of a larger family of sites that could be managed in a similar manner. One benefit would be guidelines for selecting tree species that were best suited to the ecological characteristics of a site. This could improve the success of reforestation efforts and the growth potential of species that were planted there. But resource managers also recognized that extensive work would be needed over many decades to determine suitable groupings of sites and to identify these sites in the field.

The BEC Concept

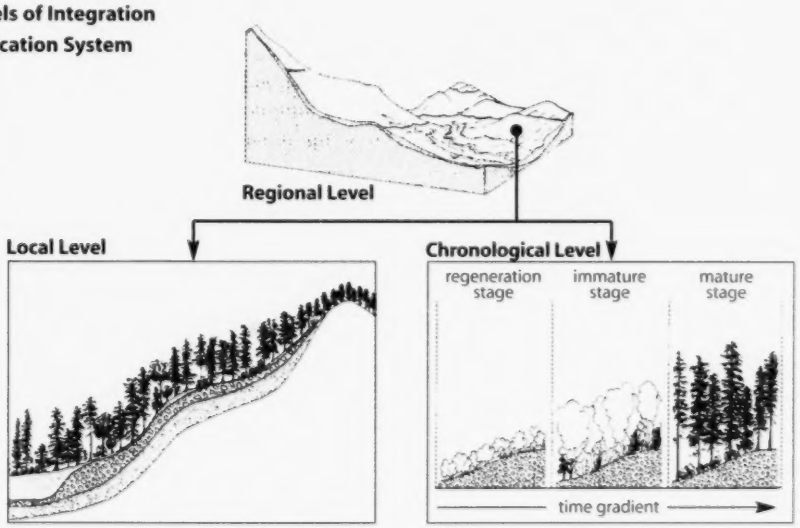
The BEC system characterizes biological and physical attributes of specific sites, then uses this framework to develop the most appropriate prescriptions for managing forest lands. These ecologically based interpretations include guidelines for managing specific sites and for predicting the short- and long-term effects of management activities on forest ecosystems.

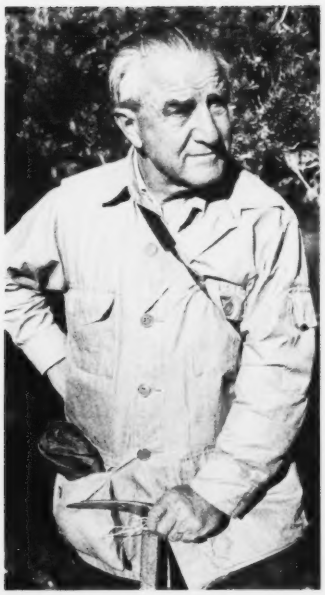
The ecological concepts that underpin the classification are those of regional climate, climax and succession, and ecological equivalence. At the most general level, the broad climate of a region is identified and classified.

Regional climatic zones are divided into subzones, and subzones into variants. However, in such a climatically and physiographically diverse province as B.C., there are insufficient climate data available to precisely delineate regional climates. Instead, BEC uses the mature-to-climax vegetation on zonal sites to reflect the regional climate. The assumption is that this vegetation is indicative of climatic and site conditions.

In the BEC system, zonal sites are reference sites that are selected to be intermediate in conditions such as moisture regime, nutrient regime, slope position, slope, aspect, and soil texture, and are located on moderately deep to deep soils. Within a homogeneous climatic zone, all zonal sites will have very similar vegetation communities.

Figure 3: Levels of Integration in the Classification System





Professor Vladimir Krajina (1905-1993)

Vladimir J. Krajina, the father of the BEC system, was born in 1905 in Czechoslovakia. He became interested in plant taxonomy very early in life, and later studied ecology from the phytosociologist Karel Domin, receiving his doctorate in 1927. After some difficult years during and after World War II, Krajina and his family arrived in Vancouver in 1949, where Krajina, then in his mid-40s, began his career at the University of British Columbia.

Through his own research and that of his graduate students, Krajina's botanical explorations of B.C. and his synthetic approach to ecological classification led him to propose a biogeoclimatic or zonal classification of the province. His integrated system was adopted by the B.C. Forest Service in the 1970s and, in an expanded and somewhat modified form, underlies much of present-day forest-land management in the province.

Vladimir Krajina died in Vancouver on June 1, 1993.

The site series is the basic classification unit used in BEC. Site-series definitions are based on data gathered from mature and climax communities, and include all sites that are capable of producing similar plant communities. These ecologically equivalent sites may not have exactly the same site features, or may include vegetation from earlier succession stages, but will, due to compensating environmental factors, develop similar vegetation over time. For example, a coarse-textured soil with seepage may be equivalent to a fine-textured soil without seepage.

The Early Days of BEC

The Forest Service's provincial BEC program formally took shape in 1975. A five-year program was launched to characterize, describe and map the biogeoclimatic units of uniform climate based on soils, site and vegetation data. Researchers also set out to describe the major forest and range ecosystems.

To implement this program, the Forest Service hired pedologists, who began preparing biogeoclimatic maps for each region and started writing the first field guides for on-site ecosystem identification. Ecologists integrated the resulting vegetation and environment data to produce a unified classification system for the province.

An integral part of the program was field training for ministry and industry staff on the BEC principles and the procedures for site identification. These training sessions played a significant role in the acceptance of ecosystem classification into forest operations.

Based on data gathered from sample plots across the province, the BEC system began to evolve from Krajina's original classification into its current form. By the late 1980s, Forest Service staff had mapped biogeoclimatic subzones and variants for all six forest regions. They produced field guides that explained how to identify the ecosystems within each subzone, and how to develop prescriptions for planting and slash-burning. By the mid-1980s, the BEC guidelines had been expanded to include interpretations for managing multiple resources, such as timber, range and wildlife. By the early 1990s, the original vision of creating a provincial ecological classification system had been fulfilled. But new challenges lay ahead, and those continue to drive the development of the BEC program.

BEC Applications in Forest Management

The influence of the BEC system in resource management in B.C. has grown steadily over the past 25 years. BEC is now the common "language" that foresters, biologists, agrologists, other resource managers, and naturalists use to describe and communicate about B.C.'s diverse terrestrial ecosystems.

At the site level, BEC interpretations have been incorporated into Forest Practices Code guidebooks, wildlife habitat mapping, and timber supply modelling. The

BEC subzones and variants have been used in planning processes such as the Protected Areas Strategy, the Identified Wildlife Management Strategy, landscape-unit planning, seed zone boundaries, and seed orchard establishment. BEC units are featured in the Forest Practices Code guidebooks on tree species selection, stocking density, free-growing guidelines, and old-forest retention. They are also increasingly used to define the timber harvesting land base and management zones for the Timber Supply Review.

The field guides describe ecosystems for 99% of the forested areas of B.C. Biogeoclimatic maps and classification reports (e.g., field guides and other early land management reports) are presently available for about 80% of the province. Maps and reports are in various stages of preparation for roughly another 10% of the province, including wetlands and grasslands. The alpine and some high-elevation and northern low-productivity forests are presently classified and mapped only at a reconnaissance level.

Needs and Opportunities for BEC

Now that the BEC system is essentially complete, with detailed ecological information organized into one comprehensive framework, research emphasis is shifting to address development of new applications needed by forest managers. Refinements to the basic system will continue to be a priority, as will maintenance of the database, but it is the adaptation of BEC to emerging issues that offers researchers the greatest opportunities to respond to needs of clients.

Emphasis is now on the following:

1. **Mapping and modelling ecological succession and habitat relationships**
   The species composition and development of young-to-mature ecosystems is not well known, because until recently, the BEC system focused on sampling mature-to-climax ecosystems. More BEC data on young forest ecosystems are needed to refine ecological habitat models, and to understand the successional dynamics of younger forests. Zones, subzones, and variants are being mapped in digital form at larger, more detailed scales. These refinements will greatly improve the quality of the information used for ecosystem mapping and will also extend the utility of the database for additional resource planning initiatives (e.g., site assessments or determining size and location of old-growth management areas).

2. **Relating ecological site characteristics and quantitative site productivity**
   BEC has contributed to the development of an indirect method to estimate site index in areas where conventional site index estimating methods cannot be easily applied (e.g., in old-growth and very young stands). As forestry moves to uneven-aged stand management, these Site Index Biogeoclimatic Ecosystem Classification (SIBEC) relationships will also help analysts model the productivity of uneven-aged and complex stands for timber supply analyses. SIBEC estimates may be easier to modify, as climate changes, than other approaches because they are correlated to climate.

3. **Supporting a results-based Forest Practices Code and certification initiatives**

   A key premise of a results-based code is that the same results can be obtained using different forest management strategies. But to implement such a code, forest managers would need a means for determining whether or not desired results will be achieved. The extensive knowledge of ecosystems that has been obtained from BEC will be valuable in establishing baseline conditions for species diversity and productivity for specific sites, and for predicting changes. In addition, by comparing actual results to those predicted for that site by BEC, forest managers will be able to evaluate the effectiveness of an applied forest management strategy. The extensive ecological knowledge and relationships inherent in BEC will be invaluable in developing sustainable forest management plans under the code.

   Certification of B.C.'s forest products will require that forest managers demonstrate that the province's forests are being managed in an ecologically sound manner. BEC has two roles to play in that process. First, because it is founded on scientifically sound ecological principles, its application will enable B.C.'s forest management to withstand critical scrutiny. Second, it provides a basis for identifying and conserving rare and sensitive ecosystems.

4. **Modelling climate change**

   Climate change would affect B.C.'s ecosystems in different ways, depending on which elements within the ecosystem are most sensitive to changes in temperature, radiation and rainfall. Combining climate surface modelling and BEC mapping with climate change scenarios would allow researchers to identify the most likely areas where species regeneration, productivity and vigour would be affected. This could provide new guidance for forest managers selecting tree species. Because BEC is based on climate, significant changes in climate would likely lead to changes in the classification of zones and sites.

5. **Developing new tools for detailed ecosystem mapping**

   Over the past five years, efforts have been made to provide more detailed ecosystem mapping of the province. Detailed site-series mapping in the past has been piecemeal because BEC site series have been mapped during the silviculture planning process. Under these circumstances, little information is gathered on future harvesting areas, or on forests that are not planned for harvest.

   Cost-effective and accurate mapping tools are needed to develop ecological maps to plan for timber supply, silvicultural treatments, wildlife and biodiversity. Ecosystem mapping over large management areas has generally been done using Terrestrial Ecosystem Mapping (TEM), a relatively costly methodology based on extensive field work and aerial-photo interpretation. Predictive mapping methods – such as the Forest Science Program model, EcoGen – are now being developed that are less expensive and do not require extensive field work and mapping from air photos. Recent applications of the EcoGen model have shown that the results can be similar in accuracy to TEM.

6. **Filling gaps in the existing BEC system**

   The data to support the BEC system were compiled from 30,000 ecosystem

field plots throughout the province. There are still small gaps in the current BEC system for sites that were remote or inaccessible at the time of the original BEC sampling, or that were not prevalent enough to be part of the sampling design. Missing data must be gathered and technical interpretations must be refined to fill these gaps, because some of the sites are now being harvested and others have been identified as sensitive, rare, at-risk ecosystems.

7. **Correlating results among regions**
   Correlation of the ecosystem classification among forest regions in the 1990s required many changes to codes and names of units to create a truly provincial classification system. Until then, each region conducted the classification at its own pace, and data were not always available from all regions. In the future, any new classification units must be correlated to ensure the integrity of BEC throughout the province.

   To address rare ecosystem conservation issues and national and international reporting on ecosystems, several groups are working with Forest Science Program ecologists to use the BEC classification and data to determine equivalency with ecosystems in their own jurisdictions. Among those are the Forest Ecosystems of Canada project, the Canadian National Vegetation Classification System, and The Nature Conservancy (through NatureServe) International Classification of Ecological Communities.

8. **Managing the database**
   Careful data management and planning is necessary to ensure that the BEC system is well integrated into various forest management systems and databases. Plot data are a valuable corporate resource, which along with the incorporation of newly acquired data, are essential to maintain and refine new applications of the BEC system.

   The province has stated its intention to fundamentally restructure the roles of government and the forest industry in managing forest resources. Government will advocate the public interest by setting policies and standards, and by ensuring compliance. Industry will pursue economic opportunities in accordance with those standards. As a result of these changes, priorities of the Ministry of Forests will evolve, as will the roles of Forest Science Program scientists in meeting client needs. Similarly, BEC will be called upon to expand beyond traditional "niches" and support emerging demands. BEC, as an integrated, multi-level ecological classification system, is well-suited to help forest managers deal with new demands, such as determining the best use of the land, integrating resource management, and developing sustainable plans. BEC can also support compliance and enforcement related to the results-based Forest Practices Code. BEC can provide the basis for not only defining desired ecological outcomes, but also contribute to the rigorous scientific basis for determining if those outcomes have been met. Another new demand will be in monitoring forest conditions, including State-of-the-Forest reporting, where site classification will provide the underlying structure for documenting the province's success in managing and protecting its natural diversity.

Regional field guides

(All published by the B.C. Ministry of Forests, Research Branch, Victoria, unless otherwise specified.)

A Field Guide to Forest Site Identification and Interpretation for the Cariboo Forest Region. Land Management Handbook No. 39. O.A. Steen and R.A. Coupé. 1997.

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Plant guides

(All published by Lone Pine Publishing, Edmonton, Alberta, unless otherwise specified. www.virtualguidebooks.com/Books/Series/LonePine.html)

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Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia, and Alaska. J. Pojar and A. MacKinnon. 1994.

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Plants of the Western Boreal Forest and Aspen Parkland. D. Johnson, L. Kershaw, A. MacKinnon and J. Pojar. 1995.

For additional information about these products, visit www.for.gov.bc.ca/research/becweb/publications-becpubslist.htm

* Also cited in the publications list at the end of this report.

Silviculture

[1] Silvicultural systems

Background

Silvicultural systems research examines the implications of using harvesting, forest regeneration, and stand management strategies to meet non-timber as well as timber forest objectives. Particular attention is being focused on alternatives to conventional clearcut harvesting because of the growing appreciation of the ecological complexity of forests, and of the non-timber values associated with them.

Summary

Approximately 20 multi-disciplinary silvicultural systems projects are located throughout B.C.

Since 1991, researchers at the Roberts Creek Study Forest on the Sunshine Coast (Vancouver Forest Region) have demonstrated the use of alternative silvicultural systems, including clearcut, dispersed retention at higher residual density, initial entry in extended rotation prescriptions, strip retention, and variable retention. Windthrow has affected all partially logged stands after treatment, but there were large differences in response to strong winds. In the dispersed retention, dominant trees remained stable, while vulnerable trees tended to blow down in the first big storms after harvesting. Trees in the strip-retention treatment were quite vulnerable to windthrow, due to increased turbulence in the presence of strong winds blowing perpendicular to the strip orientation. Branch pruning and topping of residual trees were effective treatments. Most retained trees remained standing, despite unusually severe wind storms in December 2001. In the dispersed-retention blocks, growth of Douglas-fir and western redcedar declined with increasing density of the retained canopy. Natural regeneration of western hemlock was enhanced in relation to clearcut blocks.

Results of a soil chemistry study at Sicamous Creek (Kamloops Forest Region) are refining our understanding of how nitrogen cycling changes after harvest. Researchers have found that for one to two years after harvesting, ammonium concentrations were elevated in forest floor and mineral soil in openings of 0.1 hectares and larger, whereas, three through seven years after harvesting, nitrate concentrations were elevated. A second five-year program has been initiated at the site to remeasure regeneration, stand structure, soil, wildlife, vegetation and climate indicators.

In 2001, the Uniform Shelterwood Project (Cariboo Forest Region) was expanded to examine the suitability of interior Douglas-fir forests for mule deer winter range. Thinning treatments were designed to change the stand structure to alter key attributes of mule deer winter habitat, such as forage production and snow interception.

The STEMS (Silviculture Treatments for Ecosystem Management in the Sayward) study is examining the effects of silvicultural systems that emulate patterns of natural disturbance. In 2001/02, six treatment blocks were harvested. Measurements of the long-term growth and yield plots were made before and after treatment, and will be remeasured at five-year intervals.

Cooperators

B.C. Ministry of Sustainable Resource Management

Canadian Forest Service

Forest Renewal BC

Forest Research Extension Partnership (FORREX) (formerly the Southern Interior Forest Extension and Research Partnership)

Private consultants Jen Shaw, Adrian de Groot, Colleen Jones and Shauna Bennett

Riverside Forest Products Ltd.

University of British Columbia

University of Waterloo

Weldwood of Canada Ltd.

West Fraser Mills Ltd.

(Note: Most of the research work outlined in this section of the report is carried out with the cooperation and involvement of Ministry of Forests staff in other headquarters branches and in the forest regions and districts around the province. For brevity, only external cooperators are listed.)

Applications

The results obtained from silviculture systems study areas have long-term implications for coastal and interior forest managers dealing with stand growth, composition and health. Several technical reports and extension notes have been published on the trials in the Roberts Creek Study Forest (see publications list).

A field workshop in Prince Rupert in September 2001 highlighted findings at the conclusion of the five-year HyP[3] (Pattern, Process and Productivity in Hypermaritime Forests) Project. The tour gave the 40 participants an excellent opportunity to discuss the ecology and management of low-productivity cedar-hemlock ecosystems. There was overwhelming agreement that the management of these coastal forests is a high-priority issue, considering the extent of this forest type, the high demand for cedar products, and questions concerning sustainable timber production in low-productivity ecosystems. The workshop concluded with a tour to Oona River on Porcher Island to view an operational trial demonstrating a diameter limit, ground-based ("hoe-chucking") harvesting system. Results of HyP[3] research are being incorporated into several extension products designed for forest practitioners. These include a land management handbook, a field guide supplement, extension notes, and technical research papers. For further details, see the HyP[3] website at www.for.gov.bc.ca/prupert/Research/Index.htm

The many publications produced from the Sicamous Creek study are available online (www.mountainforests.net), and silvicultural systems research is frequently demonstrated during technical forestry workshops and tours. For example, the PartCuts 2001 workshop included a tour of the Uniform Shelterwood Project (Cariboo Forest Region).

[2] Mixedwood management

Background

Mixedwood research helps the ministry refine free-growing guidelines and manage stands of broadleaf and conifer mixtures. These research results are used to develop alternative silvicultural systems for managing mixedwoods. For example, mature aspen stands may be underplanted with white spruce, or paper birch may be maintained at densities that are not detrimental to the growth of understorey Douglas-fir.

Summary

Several interrelated studies are investigating regeneration and stand-tending options in mixed-species stands in the northern boreal forest, in the central and southern interior, and on the coast. For five mixed stands of aspen and white spruce near Fort Nelson (Prince George Forest Region), stem analysis techniques were used to analyze height and radial growth patterns. In a study of mixed stands of aspen and pine in the SBSdw2 at Tyee Lake (Cariboo Forest Region), aspen trees were removed from different radii from around the pine crop trees. Results after seven years showed that, where aspen was either not removed or

left within 50 centimetres of the crop pine, the increased competition for light resulted in pine growing taller while sacrificing radial growth.

Applications

Current research results were presented on boreal and interior mixedwoods, free-growing standards, setting mixedwood stocking standards, and techniques for managing complex mixtures of paper birch and conifers:

- the "Paper Birch: Ecology and Management Conference" in Prince George (sponsored by the University of Northern British Columbia [UNBC], Forest Renewal BC, and the BC Forestry Continuing Studies Network),
- the Southern Interior Silviculture Co-operative (SISCO) winter workshop in Kamloops,
- a departmental seminar at UBC,
- the conference "Sustainable and Performance-Based Resource Management Working Forest" (sponsored by the Enhanced Forest Management Pilot Projects, the Innovative Forestry Practices Agreements, Results-Based Forest Management Pilots, UBC and the BC Forestry Continuing Studies Network), and
- a workshop in Fort Nelson that was attended by more than 50 people from licensee and natural resource agencies from B.C. and Alberta.

Cooperators

International Forest Products Ltd., Adams Lake Division

Lakehead University

Riverside Forest Products Ltd., Salmon Arm Division

Slocan Forest Products

University of Alberta

University of British Columbia

University of Northern British Columbia

Weldwood of Canada Ltd.

[3] Stand management

Background

Stand management field experiments are the primary way in which researchers document the responses of stands to silvicultural treatments and compare stand productivity under different management regimes. Long-term monitoring and remeasurement of these installations give researchers the best opportunity to calibrate and validate growth and yield models of managed stands. Models that are developed from these data help forest managers select and time appropriate silvicultural prescriptions, rationalize silvicultural investment decisions, and demonstrate the effects of various stand management treatments on timber harvest levels. Researchers establish field experiments to quantify the response of a wide variety of conifer and broad-leaved species to stand management treatments, such as espacement (or plantation density), pre-commercial and commercial thinning, fertilization, pruning, and partial cutting.

Summary

The stand management research program consists of 537 installations with about 4,500 permanent sample plots. During 2001/02, branch and regional researchers completed the scheduled remeasurement and maintenance on about 110 installations and 1,450 plots.

A small network of "maximum productivity" field experiments provides valuable data on the potential growth and yield benefits of repeated fertilization of young, managed forests in the B.C. interior, and on the long-term impacts of intensive management on ecosystem health and sustainability. Researchers and graduate students with expertise in tree physiology, forest soils and forest entomology are currently involved with ancillary research projects on these

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Weldwood of Canada Ltd.

Ingrown Stands

Ingrown stands were historically relatively open, but now have a high density of generally pole-sized and smaller stems beneath a canopy of larger trees. These high densities are the result of the very successful establishment of seedlings beneath a relatively open canopy and the absence of natural controls, such as fire, on stocking.

study sites. A total of nine "maximum productivity" installations (six for lodgepole pine and three for interior spruce) have been established in three different interior biogeoclimatic zones. Six-year results indicate that young spruce ecosystems are particularly responsive to repeated fertilization, with consistently large increases in tree growth and understorey biomass.

In a trial in the SBPSdc[1] on the Chilcotin Plateau, researchers are examining whether stand-tending treatments can increase the productivity of repressed pine stands. The ministry has estimated that there are more than 130,000 hectares in the Cariboo Forest Region of repressed pine trees that currently are not included in the land base used as the basis for determining allowable annual cut. These fire-originated stands are more than 40 years old and very dense, typically with more than 15,000 stems per hectare, at an average height of 4.5 metres. The trial was initiated in 1997 and fertilized in 1998. Third-year assessments in 2001/02 show that fertilization is required to increase height growth, and that, three years after fertilization, trees are still responding positively. Leader length averaged 26 centimetres in the fertilized treatments, compared with only 7 centimetres in the untreated controls. Based on the results of this trial, researchers have begun another trial in an older stand in the SBPSxc[1] to determine if the result can be duplicated.

A project in the Cariboo-Chilcotin IDF[1] zone was begun this year to improve management practices of ingrown Douglas-fir stands. The high densities in these stands result in reduced tree growth and vigour, and poor development of shrubs and herbaceous vegetation. Two ingrown stands adjacent to grasslands were partially logged by Riverside Forest Products Ltd. in the summer of 2001, and subsequently thinned during the winter of 2001/02. Thinning focused on retaining quality stems that showed high growth potential. Controls included portions of the blocks that were not harvested, and other portions that were harvested but not thinned. Growth and yield plots, vegetation monitoring plots, and photo points were established in each treatment. Portions of the blocks will be under-burned in spring 2002.

Applications

Stand management researchers provided information to modellers, planners and practitioners for use in stand- and forest-level decision-making and analysis. Results of stand management research were presented at a number of workshops and technical and scientific forums. Several journal papers, working papers, extension notes, research reports and conference proceedings were also published (see publications list). Research Branch and Canadian Forest Service scientists worked cooperatively to develop a web-based "expert" system to help forest practitioners evaluate foliar nutrient status and recommend appropriate fertilizer prescriptions for lodgepole pine. The system is now online at www.pfc.cfs.nrcan.gc.ca/silviculture/lodgepole/index_e.html

Also this year, a report was prepared on behalf of the Forest Productivity Council of BC to summarize the current status of the provincial growth and yield data collection program and recommendations for further work.

Repressed pine on the Fraser Plateau west of Williams Lake which have been thinned and fertilized have initially shown a very positive growth response. If these trees continue to grow at current rates, they should produce merchantable timber within approximately 50 years. This could result in an increase in timber supply that has not been included in current timber supply estimates. Results from the study of ingrown Douglas-fir stands will help the ministry develop guidelines to improve Douglas-fir growth and improve wildlife, livestock and biodiversity values in ingrown stands. This work will also contribute to the conservation work of the Cariboo-Chilcotin Grassland Strategy.

Cooperators

Maximum Productivity

Canadian Forest Service

Dunkley Lumber Ltd., Prince George

Forest Renewal BC

Forest Research Extension Partnership (FORREX) (formerly the Southern Interior Forest Extension and Research Partnership)

University of Alberta

Repressed Pine

Forest Renewal BC

Lignum Ltd., Williams Lake

Riverside Forest Products Ltd., Williams Lake

West Fraser Mills Ltd., Williams Lake

Ingrown Douglas-fir Stands

Riverside Forest Products Ltd., Williams Lake

University of British Columbia, Malcolm Knapp Research Forest

[4] Vegetation management

Background

The goal of forest vegetation management research is to help ensure successful establishment and maintenance of reforested areas to a free-growing stage. Researchers evaluate physical and biological vegetation control methods, in addition to herbicide treatments, to develop more cost-effective, environmentally sound and socially acceptable vegetation management prescriptions.

Researchers also evaluate the long-term growth and yield implications of vegetation management treatments. This provides valuable information to forest managers about free-growing requirements, mixedwood stocking standards, and the conservation of biodiversity. These studies also contribute to our understanding of stand dynamics, development and structure.

Summary

During 2001/02, vegetation management researchers launched a new study near Fort Nelson River (Prince George Forest Region) to evaluate the effects of brushing and spacing treatments on aspen-spruce mixedwood stands in the BWBS . PROBE (PRotocol for Operational Brushing Evaluations) installations were established at Champion Creek (Nelson Forest Region) and at three sites in the North Adams drainage (Kamloops Forest Region) where researchers will investigate the effects of different densities of paper birch on the performance of conifers, the incidence of the root disease *Armillaria*, and the diversity of plant communities.

Researchers also continued work this year on a number of multi-year projects throughout the province, including remeasurements at several PROBE and EXPLORE (Experimental design Protocol for Long-term Operational Response Evaluations) installations and at sites where experimental vegetation management treatments are being tested.

Cooperators

Canadian Forest Service

Forest Renewal BC

Science Council of British Columbia

Treespan Forestry Consultants Ltd., Creston

University of Alberta

Applications

In 2001/02, vegetation management researchers completed a prototype of a web-based "expert system" for site preparation and vegetation management in the southern interior of B.C. This system, which builds on the SYTEPREP computer-based system (SYstem To Evaluate PRescription Effects on Potential Productivity), provides silviculture prescription decision support by taking into account the latest vegetation management research from the southern interior.

Repressed pine on the Fraser Plateau west of Williams Lake which have been thinned and fertilized have initially shown a very positive growth response. If these trees continue to grow at current rates, they should produce merchantable timber within approximately 50 years. This could result in an increase in timber supply that has not been included in current timber supply estimates. Results from the study of ingrown Douglas-fir stands will help the ministry develop guidelines to improve Douglas-fir growth and improve wildlife, livestock and biodiversity values in ingrown stands. This work will also contribute to the conservation work of the Cariboo-Chilcotin Grassland Strategy.

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Maximum Productivity

Canadian Forest Service

Dunkley Lumber Ltd., Prince George

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University of Alberta

Repressed Pine

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Ingrown Douglas-fir Stands

Riverside Forest Products Ltd., Williams Lake

University of British Columbia, Malcolm Knapp Research Forest

Cooperators

Canadian Forest Service

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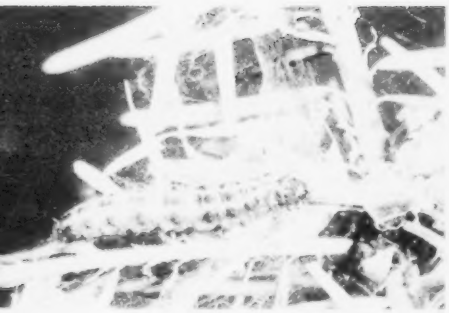
University of Alberta

Results from PROBE were presented at the "Monitoring for Performance-Based Timber Management Conference" in Richmond, B.C., and in posters at three other conferences during this year. At the national forestry workshop, "Vegetation Management in Boreal Mixedwoods" held in Quebec City, ministry researchers also presented findings about the long-term stand-level effects of vegetation management in boreal mixedwoods.

A variety of reports were also published on the effects of manual brushing and spacing treatments, biological control, and the application of herbicides (see publications list).



[5] Pest management

Background

Insects and disease cause significant timber damage and loss in B.C. In any given year, more than 2.5 million hectares may be under attack by forest insects such as bark beetles, and defoliators such as western and eastern spruce budworm and western hemlock looper. There are costs both in the short term (to fight infestation and disease, and in the commercial loss of timber) and the long term (in the loss of future volumes and regeneration stock). A better understanding of when and where to focus control measures is therefore of enormous interest to the forest industry. Researchers studying *Armillaria* continue to explore new techniques and concepts in managing the disease.

Summary

Researchers studied defoliation and tree-ring data this year to determine the historic frequency and periodicity of western spruce budworm outbreaks in the Kamloops Forest Region. They analyzed increment cores from 820 interior Douglas-fir trees and 223 ponderosa and lodgepole pine trees for the tree-ring data. A defoliation event was marked in years in which there was a reduction of more than 20% in ring width, compared with the previous 10-year average. Large defoliation events appear to have occurred between 1833 and 1851, 1918 and 1936, 1916 and 1945, 1971 and 1980, 1987 and 1995, and 1999 and 2001. Based on mapping records of defoliation, researchers know that the latter three periods of reduced growth were known outbreaks. In the next phase of the study, researchers will do an economic analysis of the volume loss from predicted defoliation events compared to the losses expected after treatment with a biological control, such as Foray 48B (*Baccilus thuringiensis* var. *kurstaki*, or *Btk*).

In 2001/02, researchers assessed mortality caused by *Armillaria* root disease through large-scale field trials established in 1996 and 1997. They found statistically and biologically significant differences: on plots treated with the competitive fungus *Hypholoma fasciculare*, there were some 66% fewer mortalities than on untreated plots.

Applications

With the results from the spruce budworm study, forest managers will be better able to determine the likelihood of a defoliation event occurring in the life of a given stand. In other applications, a summary on forest health was published in the *Kamloops Region 2001 Aerial Overview Report*, and approaches being investigated in *Armillaria* research studies show promise for greatly increasing the number of management options available to fight this significant forest disease.

Cooperators

Armillaria

Denise English Woodlot
Forest Renewal BC
Global Forest Society
West Fraser Timber Co. Ltd.

Spruce Budworm

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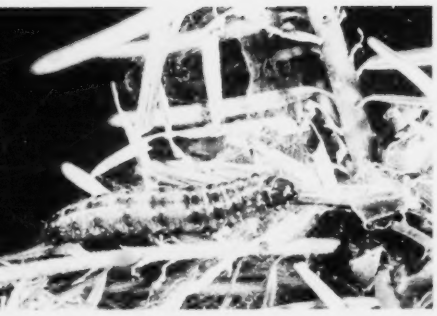

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[1] Stand model development

Background

Forest practices are changing rapidly, as resource management shifts away from traditional clearcutting toward ecosystem management. Silvicultural systems such as selection harvesting and variable retention generate more complex spatial distributions and stand structures. Foresters in the districts, regions and headquarters are requesting reliable quantitative information. Since very few long-term data exist for complex stands, growth and yield researchers are developing or updating models, including the Tree and Stand Simulator (TASS), Table Interpolation Program for Stand Yield (TIPSY), and Prognosis[ca], to realistically project stand structures over time.

TIPSY is a scaled-down operational version of the TASS model. Both TASS and TIPSY use stand attributes and other inputs to predict potential and operational yields of managed forests, and to conduct financial analyses. Prognosis[ca] uses ground-based inventory data to predict operational yields of mixed-species coniferous stands. Field studies are improving our understanding of how biological processes and alternate silvicultural systems affect complex stand attributes (e.g., stand density, age structure, and species composition).

Summary

During 2001/02, researchers expanded the capabilities of existing models and developed supporting visualization software.

TASS

Researchers are developing a natural regeneration module for drybelt IDF[dk] stands and extending TASS calibration to mixed-species ICH[mw] stands. In several studies, they explored the factors affecting regeneration success in dry-belt interior Douglas-fir stands. At the Pothole Creek Study Area and at a site near Westwold (southeast of Monte Lake) both in the Kamloops Forest Region, researchers tested methods of measuring spatial patterns of soil moisture availability. They took measurements of seed fall, germination, and seed predation at Pothole Creek, and of understorey development at the Opax Mountain Silviculture Systems Trial (also in the Kamloops Forest Region).

This year, researchers compared existing growth equations for hemlock and Douglas-fir, using data collected from trees growing in the interior cedar–hemlock zone (ICHmw2 and ICHmw3[ ]). Growth equations for coastal and interior hemlock are similar, but Douglas-fir in the ICH will require different coefficients than those for coastal or dry-belt uneven-aged Douglas-fir.

To simulate the light environment for mixed-species stands, researchers analyzed hemispherical photographs from ICH stands of Douglas-fir, hemlock, and paper birch to determine light penetration through the canopy. With these data, researchers will derive first estimates of light distribution used in the TASS model.

Researchers are also exploring architectural changes to TASS, to calibrate the model for deciduous species. For red alder, calibration has focused on simulating mortality and growth in pure naturally regenerated stands. Development efforts

for aspen have focused on tree growth variation and on understanding the species' unique crown, branch and bole properties. Once these species are included, the researchers will extend the model to include mixed stands of coniferous and deciduous species.

Economists and growth and yield researchers updated the economic module of TIPSY to reflect current costs and revenues, and to enhance its role as a decision-support system for silvicultural treatments and management planning.

Prognosis[BC]

Prognosis[BC] can project the development of mixed-species coniferous stands, regardless of the structure and stage of development of the stand, as long as ground-based inventory information can define the existing structure. Researchers are using the model to develop growth and yield projections to simulate natural regeneration and growth following a disturbance in complex, uneven-aged stands in the IDF and the ICH zones[1] of the southern interior. This year they constructed tables for assessing natural regeneration after disturbance for the IDFdk1, IDFdk2 and IDFdk3, and incorporated new growth and mortality functions. They also updated functions to predict diameter growth and tree mortality, and expanded the functions to include hardwood species. During 2001/02, researchers also classified growth and mortality data into site index groups using Site Index Biogeoclimatic Ecosystem Classification (SIBEC) (which incorporates both site index and ecological classification), which will help analysts generate more precise growth and mortality functions.

Wood Quality / Crown Characteristics

Both the quantity and the quality of wood fibre produced by a stand are affected by silvicultural activities. Modern growth and yield models predict the volume of wood that will be created, but few predict the quality of wood in second-growth stands. Second-growth wood quality is significantly affected by the characteristics of tree crowns. Large crowns usually produce a higher proportion of juvenile wood that, for most products, is inferior in quality to mature wood. The mature wood of relatively large-crowned trees is also weaker, because of lower relative density and the higher frequency of large knots. These qualities diminish product value, since strong, clear boards are historically worth three to four times as much as boards containing knots.

To construct the model, researchers analyzed data collected on western hemlock over the previous four years, to develop relationships for the distribution of branches, the leaf area and biomass of foliage, and the correlation between these characteristics and wood quality. All relationships were significantly improved by the inclusion of ecological classifications as predictor variables. Researchers are also investigating genetic effects to determine if there are differences between families in the relationships between crown characteristics and wood quality.

Applications

As background for development of a TASS regeneration model, researchers prepared a literature review on the regeneration of Douglas-fir in the southern interior dry-belt after partial cutting. Researchers have also created a library of

hemispherical photos and analyzed digital images, to compare point estimates of light distribution with model estimates. The images, which may also be used to estimate leaf area and canopy closure, are available for pure stands of wet-belt Douglas-fir, western hemlock, and paper birch.

Changes to Prognosis^{BC} will result in improved models for predicting the growth and yield of uneven-aged and multi-species stands. Predictions generated from wood-quality models can help guide silviculture investment decisions made by licensees.

In August 2001, ministry researchers gave presentations on wood-quality models and on the use of TASS for complex stands to an international audience at a conference on forest modelling, sponsored by the Ministry of Forests, UBC, and the International Union of Forest Research Organizations. Researchers also presented the results of wood-quality studies to foresters at two advanced silviculture training modules this year, in which attendees were introduced to simulations of the effects of silvicultural practices on wood-quality attributes.

Cooperators

TASS

International Forest Products Ltd., Adams Lake Division

J.S. Thrower and Associates Ltd.

Prognosis^{BC}

University of British Columbia

Wood Quality / Crown Characteristics

Forintek Canada Corp.

Pulp and Paper Research Institute of Canada (Paprican)

University of British Columbia

[2] Model implementations

Background

Researchers are developing models that resource managers can apply to select silvicultural treatments to achieve future harvest goals for volume, value, habitat and employment. Model predictions are widely used to support timber supply analyses, and for the determination of allowable annual cuts.

Summary

Researchers are developing and applying decision-support systems – based on the Research Branch suite of growth and yield tools – to relate silvicultural treatment responses to management objectives. A key goal is to provide operational decision-makers and consultants with sound analytical techniques for forest investment planning. This year, researchers assessed the merits of spacing high-density stands of juvenile interior lodgepole pine and coastal hemlock. If the stands are treated early enough to avoid height-growth repression, spacing extremely dense lodgepole pine on more productive sites increases harvest volume and provides an acceptable return on the investment. Spacing of coastal hemlock offers little promise.

Also this year, researchers completed the first approximation of the TASS model for red alder and used it to explore the effects of red alder ingress into conifer plantations on plantation growth and yield. They compared the results with managed-stand data that was provided by the Hardwood Silviculture Cooperative. For aspen, researchers have collected tree-level data from a wide range of aspen sites near Dawson Creek and Fort St. John (Prince George Forest Region). This represents the first step in calibrating TASS for aspen.

Applications

Researchers gave presentations on the decision-support system to several different groups of forest managers and policy analysts in B.C., a growth and yield cooperative in Alberta, and a meeting of the Society of American Foresters

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Cortex Consultants Inc.

Hardwood Silviculture Cooperative (Members: B.C. Ministry of Forests; Bureau of Land Management, Washington Department of Natural Resources; Goodyear-Nelson Hardwood Lumber Company; Oregon Department of Forestry; Siuslaw National Forest [Oregon]; USDA Forest Service Pacific Northwest Experiment Station; Washington Hardwood Commission)

University of Alberta

in Portland, Oregon. Researchers also prepared a draft document, "Identifying opportunities for pre-commercial thinning," which will be the basis of a more formal extension publication in 2002/03.

A research team from the University of Alberta developed the Mixedwood Growth Model with support from both the Research Branch and the B.C. Ministry of Sustainable Resource Management. Ministry of Forests researchers reviewed a new version released in the fall of 2001, and made recommendations for its operational use in B.C.

[3] Site productivity

Background

Forest management planners need to accurately estimate both the present growth and yield and the future timber volumes of the province's forests. Site productivity research, guided by client input (and prioritized by the Forest Productivity Council of BC), is improving our ability to accurately estimate site index, which is a measure of site productivity and a critical element in determining sustainable levels of timber harvesting. Reliable site index and associated yield information helps the forest industry obtain certification for the province's forest products.

Summary

In 2001/02, researchers collected and analyzed data to construct a site index model for ponderosa pine. One hundred plots were sampled throughout the range of ponderosa pine in B.C., where the trees were felled and split open longitudinally. Researchers determined annual height by identifying and measuring the pith nodes, which occur where height growth ceases each year. They sampled approximately 60 plots in three biogeoclimatic zones to validate growth intercept models for lodgepole pine and interior spruce. The data will allow researchers to test whether the model needs to be modified for local conditions.

Applications

Researchers released several growth intercept models this year which allow the estimation of site index in juvenile stands of black spruce. They also presented a method of assessing growth intercept models, and the results of a test of the coastal Douglas-fir model, which were shown to work well in juvenile managed stands. Researchers also published a report that showed little difference in height-growth patterns among species, but differences were evident between shade tolerant and intolerant species, and between trees growing in the interior and on the coast. Although more research needs to be done in this area, these findings indicate that we might be able to generalize, instead of localize, the site index models.

Cooperators

B.C. Ministry of Sustainable Resource Management

Cooperators

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Hardwood Silviculture Cooperative (Members: B.C. Ministry of Forests; Bureau of Land Management, Washington Department of Natural Resources; Goodyear-Nelson Hardwood Lumber Company; Oregon Department of Forestry; Siuslaw National Forest [Oregon]; USDA Forest Service Pacific Northwest Experiment Station; Washington Hardwood Commission)

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Cooperators

B.C. Ministry of Sustainable Resource Management

[1] Ecosystem classification

Background

The Biogeoclimatic Ecosystem Classification (BEC) system provides a framework for the long-term management and conservation of forest and range land ecosystems. The system is used in many applications, including landscape-level modelling and stand-level modelling tools such as Prognosis[SC], site prescriptions, landscape planning, rare ecosystem identification, and wildlife habitat assessment.

Further background on the BEC system can be found in the feature article on pages 6 to 13 of this report.

Summary

The BEC program has embarked on a stepwise plan to improve access to ecological information, expand the scope of the classification, and enhance application of the system to address changing client needs and priorities. In 2001/02, researchers updated the original BEC data used for regional field guides by adding latitude and longitude coordinates and soils information. Future steps will be to acquire additional plot data and integrate them into the provincial classification, and to publish and apply new BEC classifications.

During 2001/02, researchers completed field sampling in interior forest districts to provide site-series classifications of previously unclassified and inaccessible areas. These included upper-elevation subalpine ecosystems of the southern Prince Rupert Forest Region, forested site-series classification for the MSxk[1] in the southern 100 Mile House Forest District, and an expanded classification of the SBSmw[1] in the Quesnel Forest District. Correlated site-series classifications were completed for grassland ecosystems of the BG and IDFxm subzones[1] (the most northerly extensive arid bunchgrass grasslands in B.C.), and for seral ecosystems dominated by aspen and balsam poplar in the northeastern Prince George Forest Region.

Researchers completed large-scale (1:50 000) biogeoclimatic mapping for extensive areas of the Prince Rupert and Prince George forest regions and part of the Nelson Forest Region using new plot data and procedures.

Also this year, the provincial SIBEC data warehouse was redesigned, and researchers developed an analysis tool to update the first approximation estimates. In addition, they added data collected since 1995 to the SIBEC data warehouse and the estimate updates.

Applications

Researchers made available updated, larger-scale biogeoclimatic maps in the Kootenay Lake, Cranbrook, and Vanderhoof forest districts this year. Volumes 6 and 7 of the *Illustrated Flora of British Columbia* were published, as well as the second edition of *Rare Vascular Plants of British Columbia* (see publications list). These publications update the nomenclature, codes and species information in the *British Columbia Plant Species Codes and Selected Attributes*, Version 4 database. Researchers also produced a field guide supplement to expand the

Cooperators

Arrow Forest Licence Group

Boreal Research and Development Ltd.

B.C. Ministry of Sustainable Resource Management

Canadian Forest Products Ltd., Chetwynd

Crestbrook Forest Industries, Cranbrook

Okanagan Innovative Forestry Society

Riverside Forest Products Ltd.

University of British Columbia

site-series classification of the SBSmw . A discussion paper,"High-Elevation Summit Discussion Paper I: Engelmann Spruce–Subalpine Fir Woodland and Parkland," on the classification and management of high-elevation woodlands and parklands in the ESSF, was made available on the Research Program website, at www.for.gov.bc.ca/research

- The updated BEC database is available online through the BEC website at www.for.gov.bc.ca/research/becweb
- Updated SIBEC estimates that improve site productivity estimates for timber supply analyses are available at www.for.gov.bc.ca/research/spwg/sibec/sibec1.htm
- Custom reports are available using the interactive SIBEC web tool.

[2] Coarse woody debris

Background

Coarse woody debris (CWD) plays a vital role in the maintenance of biodiversity and long-term site productivity. Usually defined as dead and downed material greater than 7.5 centimetres in diameter, its contribution to ecosystem structure and function has been the subject of considerable research in recent years.

Summary

The Coarse Woody Debris Provincial Technical Working Group, which is charged with developing CWD management recommendations, continued its work this year in the Vancouver Forest Region. Accomplishments included:

- developing procedures to sample piles of CWD, in addition to dispersed pieces in cutblocks,
- continued sampling of dispersed and piled CWD on harvested sites in the Kamloops, Nelson and Prince George forest regions,
- modelling of CWD decay, based on known decay rates for different tree species and piece sizes, and
- intensive studies of harvesting practices and different approaches to managing for CWD retention.

Cooperators

B.C. Ministry of Water, Land and Air Protection

Forest Engineering Research Institute of Canada (FERIC)

Houston Forest Products Ltd.

International Forest Products Ltd.

Timberline Forest Inventory Consultants Ltd.

TimberWest Forest Ltd.

Weyerhaeuser Canada Ltd. (B.C. Coastal Group)

Applications

Results from intensive research trials on the coast and in the central interior about how forest harvesting operations can be modified to accommodate CWD management objectives will provide information needed for the new results-based Forest Practices Code.

In the Vancouver Forest Region this year, researchers published a technical report about recent developments in CWD sampling methodologies comparing the efficiencies of six different CWD sample plot layouts. They also published an extension note on procedures for measuring piece lengths of CWD. Members of the technical working group gave presentations at the annual meeting of the Northern Silviculture Committee and the Northern Interior Vegetation Management Association in Prince George.

Cooperators

Arrow Forest Licence Group

Boreal Research and Development Ltd.

B.C. Ministry of Sustainable Resource Management

Canadian Forest Products Ltd., Chetwynd

Crestbrook Forest Industries, Cranbrook

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University of British Columbia

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[3] Landscape ecology

Background

Landscape ecology research addresses the influence of natural disturbances and resource management activities on landscape-level patterns and processes. Researchers have recently described natural ecosystem patterns to enable management at smaller spatial scales, and data management and analytical techniques to characterize the complexity of landscapes for forest management plans.

Summary

In the sub-boreal interior of the Lakes, Morice, and Bulkley forest districts (Prince Rupert Forest Region), researchers are gathering baseline information on disturbance rates and spatial patterns to model natural disturbance regimes in landscapes. The investigation is part of the Morice/Lakes Innovative Forestry Practices Agreement, and includes the design of models to evaluate biodiversity and responses of selected species.

On the coast, research staff from the Prince Rupert Forest Region are helping design procedures for environmental risk assessment under the North Coast Land and Resource Management Plan. They have adopted a decision-support system for modelling uncertainty (known as a Bayesian belief network) to model biodiversity and high-priority species. Researchers are also developing a provincial-scale risk assessment model for the marbled murrelet, a threatened forest-nesting seabird. In this procedure, they will link spatial modelling of the landscape with habitat supply and population dynamics models.

In the transitional coast-interior ICH forests of the Kispiox Forest District (Prince Rupert Forest Region), researchers conducted field work funded by Forest Renewal BC to develop decision-support tools for selecting silvicultural strategies. The support tools use the presence and abundance of bird species as indicators of stand and landscape biodiversity.

The Robson Valley Landscape Model was developed to evaluate the effects of uncertainty in the timing of natural disturbances on spatial modelling of forest-stand dynamics. Sub-routines of the model simulate ecological succession, western hemlock looper outbreak, infestation by mountain pine beetle, stand-replacing fire, and a variety of forest management options. Using this model, researchers should be able to better understand the limitations on predictive modelling of uncertainty about natural disturbance occurrences. In a related Research Branch project, researchers are studying how to incorporate natural disturbance into timber supply models.

In cooperation with the Canadian Forest Service, researchers have combined two map databases about historic wildfire activity in B.C. into a single digitized dataset. It contains approximately 15,000 wildfires of greater than 20 hectares in size which occurred between 1919 and 1988. Design and testing were also done on a web-based interface that will enable users to view wildfire locations and download data.

In a related project, researchers analyzed a separate dataset of statistical information for wildfires that occurred between 1950 and 2000. The resulting summaries of wildfire activity are broken down by year, cause and location and will be used in timber supply analyses and other applications.

Cooperators

B.C. Ministry of Sustainable Resource Management

Canadian Forest Service

Cortex Consultants Inc.

Forest Renewal BC

Russell Klassen, Consultant, Smithers

Morice/Lakes Innovative Forestry Practices Agreement

Pacific GeoTech Systems Ltd.

Robson Valley Enhanced Forest Management Pilot Project Community Advisory Group

University of Arizona

University of British Columbia

In the wet, cold interior cedar-hemlock (ICH[1]) zone of east-central B.C., forest disturbance history is difficult to reconstruct because heart-rot in the dominant western redcedars limit the use of dendrochronology. In this mountainous terrain, an alternative approach was used to perform radiocarbon dating on soil charcoal that was created by past fires and preserved by geomorphic processes. Evidence from samples that were dated at up to 8500 years Before Present suggests that fire was an important disturbance agent in this zone throughout the Holocene epoch. In complementary studies in the Morkill River drainage and adjacent ICH watersheds, researchers are reconstructing Holocene vegetation and fire history using pollen studies of lake sediments and peats.

Research Branch staff conducted three additional studies of natural disturbance. The first was a study of 39 natural disturbance agents that can affect timber supply. Researchers used 44 attributes to describe disturbance occurrence and spread, severity, and synergy with other disturbances (e.g., fire, logging, and climate change). Using a survey of the past 20 years of literature on natural disturbance and timber supply modelling, researchers prepared a summary of how forestry jurisdictions in Canada currently account for natural disturbance in their timber supply models and allowable annual cut determinations. They developed an experimental model and applied it to assess alternate methods for including natural disturbance events in a timber supply model, at a range of disturbance rates.

Applications

Researchers have used the revised Robson Valley Landscape Model to develop a series of scenarios to simulate increased mountain pine beetle infestations, fire suppression, long-term climate change, and alternative forest management responses to disturbance (e.g., aggressive salvage in non-protected areas, and preferential anticipatory harvest in susceptible stands). They evaluated scenarios against an array of indicators of timber supply and biodiversity. While most summary indicators (e.g., total volume harvested, or percent area in each age class) varied less than 10% among scenarios, more specific indicators varied by as much as 200%, particularly those directly related to the effects of natural disturbances (e.g., volume of non-recovered losses).

Resource planners are incorporating the results of natural disturbance regime research into land-use plans and protected area management plans.

[4] Wildlife

Background

The focus of wildlife research is on species that are sensitive to forest management activities. Research priority is being given to the development of management options and silvicultural systems that accommodate both timber harvesting and the maintenance of wildlife habitat.

Summary

Wildlife researchers monitored mountain and northern caribou populations this year by using winter surveys in the Rocky Mountains and the Caribou Mountains. Researchers tracked radio-collared animals to determine their habitat use.

Mountain caribou studies were continued in the Columbia and Salmon Arm forest districts (Nelson and Kamloops forest regions, respectively). In the Clearwater Forest District (Kamloops Forest Region), researchers studied stand-level patterns of habitat selection in detail. In another project, researchers conducted a census of caribou populations in all interior forest regions.

In radio-telemetry projects, researchers are documenting the distribution, habitat use patterns, and population characteristics of grizzly bears in the Cranbrook Forest District (Nelson Forest Region). In the Prince George and Nelson forest regions, researchers are also identifying grizzly bear seasonal movements, home ranges, and habitat selection. They visited sites used by grizzlies to determine habitat characteristics and feeding activity. Hair samples used for DNA testing were collected, as a basis for an inventory of grizzly populations. Researchers have developed habitat suitability maps and generic cumulative effects models from this information, to evaluate how different human activities affect grizzly bear habitat use and quality.

Researchers are involved in developing protective mechanisms for marbled murrelets and their habitat. In partnership with Simon Fraser University and Environment Canada's Canadian Wildlife Service, researchers are using telemetry to locate nests, obtain data on habitat use and selection (terrestrial and marine), study the effects of habitat fragmentation, and develop tools such as aerial photos and low-level flights to help identify habitats for management. In another project, researchers are taking an inventory of marbled murrelets on the north coast, and developing habitat suitability indices based on the inventory results. As part of the conservation assessment for the Marbled Murrelet Recovery Team, researchers have also undertaken a risk analysis of management options.

Applications

During this year, researchers developed decision-support tools to predict stand development patterns and provide interpretations of habitat suitability for wildlife using the TELSA model. Wildlife research results have been used as input by a number of land-use planning committees, including those for the Cariboo-Chilcotin and Kootenay-Boundary land-use plans, the Caribou Strategy Committee, the Kootenay mountain caribou and grizzly bear guideline committees, the Salmon Arm and Kamloops caribou committees, the B.C. Mountain Caribou Technical Committee and the Revelstoke Minister's Advisory Committee. Researchers have also participated directly on many of these committees, sharing knowledge and research results through daily work with operational staff.

Wildlife research results have been incorporated into the Northern Caribou Strategy (March 2002), which will guide forest management on 1.5 million hectares of caribou habitat in the Cariboo Forest Region. In other wildlife work, researchers prepared reports for the B.C. Mountain Caribou Technical Advisory Committee on the abundance, distribution and habitat use of the caribou, and contributed to management plans drafted by the Mule Deer Winter Range Committee to maintain range under conditions of shallow and moderate snowpack.

Among a number of other publications this year, researchers wrote or contributed to recommendations for maintaining mountain caribou habitat in managed forests, the northern caribou strategy (published by B.C. Ministry of Water, Land and Air Protection), and managing for grizzly bear security areas in

Cooperators

Caribou Habitat

B.C. Ministry of Water, Land and Air Protection

Downie Timber Ltd.

Parks Canada

Revelstoke Community Forest Corporation

Riverside Forest Products Ltd., Soda Creek Division

Weldwood of Canada Ltd., Williams Lake and Quesnel

West Fraser Timber Company Ltd., Quesnel

TELSA

Bonaparte Indian Band

Little Shuswap Indian Band

Grizzly Habitat

B.C. Ministry of Sustainable Resource Management

B.C. Ministry of Water, Land and Air Protection

Canadian Forest Products Ltd.

Parks Canada

Tembec Industries Ltd.

The Pas Lumber Co. Ltd.

University of Alberta

University of Northern British Columbia

Marbled Murrelets

B.C. Ministry of Water, Land and Air Protection

Dr. Alan Burger

Canadian Forest Products Ltd.

Cortex Consultants Inc.

International Forest Products Ltd.

Simon Fraser University

TimberWest Forest Ltd.

University of British Columbia

Western Forest Products Ltd.

Cooperators

B.C. Ministry of Sustainable Resource Management

Canadian Forest Service

Cortex Consultants Inc.

Forest Renewal BC

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Wildlife researchers monitored mountain and northern caribou populations this year by using winter surveys in the Rocky Mountains and the Caribou Mountains. Researchers tracked radio-collared animals to determine their habitat use.

Mountain caribou studies were continued in the Columbia and Salmon Arm forest districts (Nelson and Kamloops forest regions, respectively). In the Clearwater Forest District (Kamloops Forest Region), researchers studied stand-level patterns of habitat selection in detail. In another project, researchers conducted a census of caribou populations in all interior forest regions.

In radio-telemetry projects, researchers are documenting the distribution, habitat use patterns, and population characteristics of grizzly bears in the Cranbrook Forest District (Nelson Forest Region). In the Prince George and Nelson forest regions, researchers are also identifying grizzly bear seasonal movements, home ranges, and habitat selection. They visited sites used by grizzlies to determine habitat characteristics and feeding activity. Hair samples used for DNA testing were collected, as a basis for an inventory of grizzly populations. Researchers have developed habitat suitability maps and generic cumulative effects models from this information, to evaluate how different human activities affect grizzly bear habitat use and quality.

Researchers are involved in developing protective mechanisms for marbled murrelets and their habitat. In partnership with Simon Fraser University and Environment Canada's Canadian Wildlife Service, researchers are using telemetry to locate nests, obtain data on habitat use and selection (terrestrial and marine), study the effects of habitat fragmentation, and develop tools such as aerial photos and low-level flights to help identify habitats for management. In another project, researchers are taking an inventory of marbled murrelets on the north coast, and developing habitat suitability indices based on the inventory results. As part of the conservation assessment for the Marbled Murrelet Recovery Team, researchers have also undertaken a risk analysis of management options.

Applications

During this year, researchers developed decision-support tools to predict stand development patterns and provide interpretations of habitat suitability for wildlife using the TELSA model. Wildlife research results have been used as input by a number of land-use planning committees, including those for the Cariboo-Chilcotin and Kootenay-Boundary land-use plans, the Caribou Strategy Committee, the Kootenay mountain caribou and grizzly bear guideline committees, the Salmon Arm and Kamloops caribou committees, the B.C. Mountain Caribou Technical Committee and the Revelstoke Minister's Advisory Committee. Researchers have also participated directly on many of these committees, sharing knowledge and research results through daily work with operational staff.

Wildlife research results have been incorporated into the Northern Caribou Strategy (March 2002), which will guide forest management on 1.5 million hectares of caribou habitat in the Cariboo Forest Region. In other wildlife work, researchers prepared reports for the B.C. Mountain Caribou Technical Advisory Committee on the abundance, distribution and habitat use of the caribou, and contributed to management plans drafted by the Mule Deer Winter Range Committee to maintain range under conditions of shallow and moderate snowpack.

Among a number of other publications this year, researchers wrote or contributed to recommendations for maintaining mountain caribou habitat in managed forests, the northern caribou strategy (published by B.C. Ministry of Water, Land and Air Protection), and managing for grizzly bear security areas in

Cooperators

Caribou Habitat

B.C. Ministry of Water, Land and Air Protection

Downie Timber Ltd.

Parks Canada

Revelstoke Community Forest Corporation

Riverside Forest Products Ltd., Soda Creek Division

Weldwood of Canada Ltd., Williams Lake and Quesnel

West Fraser Timber Company Ltd., Quesnel

TELSA

Bonaparte Indian Band

Little Shuswap Indian Band

Grizzly Habitat

B.C. Ministry of Sustainable Resource Management

B.C. Ministry of Water, Land and Air Protection

Canadian Forest Products Ltd.

Parks Canada

Tembec Industries Ltd.

The Pas Lumber Co. Ltd.

University of Alberta

University of Northern British Columbia

Marbled Murrelets

B.C. Ministry of Water, Land and Air Protection

Dr. Alan Burger

Canadian Forest Products Ltd.

Cortex Consultants Inc.

International Forest Products Ltd.

Simon Fraser University

TimberWest Forest Ltd.

University of British Columbia

Western Forest Products Ltd.

Banff National Park and the central Rocky Mountains. In addition, they produced a technical report describing a methodology using aerial photos for identifying, describing and managing forests containing marbled murrelet breeding habitat in coastal B.C.

[5] Range ecosystems

Background
Range research adds to the knowledge the ministry needs to conserve grassland and open forest ecosystems, produce forage for domestic livestock and wildlife, and manage livestock grazing tenures.

Summary
In an adaptive management project under the Terrestrial Ecosystem Restoration Program, researchers are monitoring understorey vegetation changes and residual stand structure following thinning and burning of ingrown forests in fire-maintained ecosystems.

To combat forest encroachment that has substantially reduced livestock and wildlife forage, the Cariboo-Chilcotin Land-Use Plan established livestock grazing targets and goals for conserving grassland species and ecosystems. Areas designated in the region have been mapped for long-term management as grasslands rather than as forests. Resource managers have identified forest encroachment within these mapped areas, and have set objectives for the restoration of grasslands and open forest–grassland associations. Researchers are supporting the restoration of grasslands and open forest–grassland associations by trying to relate stand structure to tree growth and vegetation, collecting data on tree density, tree growth, and vegetation from ingrown stands that were historically open and adjacent to the grasslands.

In another adaptive management project, researchers are examining alternative livestock management in areas that are associated with lakes and ponds. The project is designed to help resource managers maintain or restore the natural function of the riparian areas in grassland communities, as required by the Forest Practices Code.

Cooperators

Agriculture and Agri-food Canada
University of British Columbia

Applications
During 2000/01, researchers did extension work on the integration of forest and range activities. This included the results of a long-term project on the effects of cattle trampling and browsing on lodgepole pine, and approaches to achieve the sustainable use of riparian and dry-forest ecosystems.

[6] Non-timber forest products

Background
B.C.'s forests contain a wide array of botanical and fungal resources that are integral components of forest ecosystems. Many of these also have economic and cultural importance as non-timber forest products (NTFP). Researchers are working to better understand the ecological relationships of these resources and to develop management practices that will sustain NTFP activities.

Summary

As part of the North Island NTFP Demonstration Project, researchers are developing an inventory protocol for NTFPs, to identify NTFP opportunities and to collect baseline ecological data on species distribution and abundance. Similar work was undertaken as part of the Robson Valley Enhanced Forest Management Pilot Project.

Highly productive pine mushroom sites occur in northwest B.C., where soils are well-to-very-rapidly drained and generally coarse in texture, often with a high coarse-fragment content and thin forest floor. Western hemlock is the dominant tree species, with an understorey of sparse herb and shrub layers, and a high coverage of mosses. The relatively low areal extent of these valuable forests demonstrates the need to better protect and manage the pine mushroom resource.

With Forest Renewal BC funding, a cooperative project was established between the Ulkatcho Indian Band, mushroom pickers and researchers from the Cariboo Forest Region. The main objectives of the study are to learn more about where and under what conditions pine mushrooms grow, how weather patterns affect yield, and ways in which logging might be more compatible with pine mushroom harvesting.

Approximately 70 well-characterized transect plots have been established in the study area, which covers approximately 10,000 square kilometres and four different biogeoclimatic zones. Plots are also located in areas where the mushrooms do not grow. A system for measuring yields on the plots has been developed, and six weather stations have been installed. Two cutblocks have been selected for modified logging practices to enhance yields, and a third block is currently being sought.

Pine mushrooms grow in association with lodgepole pine, and a few other tree species, which form tuberculate mycorrhizae. A study begun in 1998 in the Cariboo Forest Region is investigating the function of tuberculate mycorrhizae. Methods include detecting nitrogen fixation ability in the field using acetylene reduction techniques and identifying the DNA of the fungal and bacterial symbiont, analyzing the nitrogen isotopes, and determining the mass of tuberculate mycorrhizae.

In a study in partnership with three First Nations in the southern interior, researchers gathered information to identify forest management practices that will help sustain black huckleberry. Based on biogeoclimatic ecosystem classification, sites predicted to have black huckleberry plants were correlated with sites known to yield good berry crops. Researchers also used a questionnaire to generate feedback from First Nations communities about current management practices.

Applications

The results of ecosystem-based assessments are now being used to predict the distribution and relative abundance of NTFP plant species in older age classes of different ecosystem types. With this additional information, researchers may be able to estimate NTFP plant species in younger age classes.

Cooperators

Robson Valley

B.C. Ministry of Water, Land and Air Protection

Tysig Ecological Research

Northern Vancouver Island

Royal Roads University

Tysig Ecological Research

Pine Mushrooms

Boreal Research and Development Ltd.

Northwest Institute for Bioregional Research

Oikos Ecological Services Ltd.

Ulkatcho Indian Band

Yun Ka Whu'ten Holdings Ltd.

Mycorrhizae

Forest Renewal BC

Riverside Forest Products Ltd.

University of British Columbia

Berry Project

Ktunaxa-Kinbasket Tribal Council

Little Shuswap Indian Band

Tmixw Research, Nicola Tribal Association

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Tysig Ecological Research

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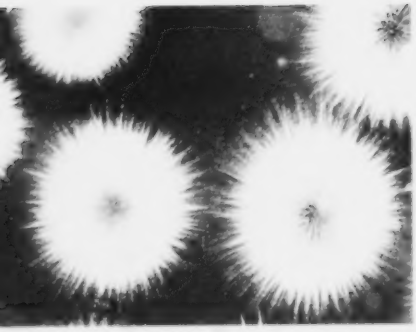
Tmixw Research, Nicola Tribal Association

Presentations of NTFP research have been made at three international conferences, and a PhD thesis and four manuscripts are currently in preparation. Results from this work could fundamentally change our understanding of the nitrogen cycle in lodgepole pine forests, and have far-reaching management implications.



[1] Watershed management

Background

Knowing how the hydrological cycle interacts with other watershed processes, and how forestry activities may affect these processes, is essential to developing appropriate watershed management practices. Watershed research is helping clarify how water is generated in forest stands, how water flows over and through the soil, where sediment is generated in the landscape, and how sediment affects water quality and fish habitat.

Summary

In the Kamloops Forest Region, long-term channel monitoring is being used to document stream channel architecture and response characteristics, as a function of forest development. Data from permanent channel cross-sections are being used to document channel morphology and function. Scanned and spatially corrected photos are combined to create mosaics that form a single ortho-image of a 100-metre section of each stream. This allows researchers to develop accurate large-scale maps, on which they can delineate riparian areas and plot stream features such as water surface, bar surface, coarse woody debris, large boulders, stone lines, pools, riffles, cascades, and log jams. Researchers are also including data on natural hillslope processes, to improve our understanding of how changes in sediment and large organic debris influence stream channels.

At Upper Penticton Creek in the Kamloops Forest Region, researchers are collecting and using data on transpiration, rainfall interception, soil water content, and water drainage from the root zone to determine the annual water balance of the watershed research site. To evaluate the response of trees to weather variables, researchers measured transpiration in 120-year-old lodgepole pine trees. They found that significant differences in water use among trees could primarily be explained by corresponding differences in leaf areas. Daily transpiration rates were at the lower end of those generally observed for temperate forests, probably due to the increased hydraulic resistance to waterflow in old trees.

To determine whether current forestry practices in the Forest Practices Code *Riparian Management Area Guidebook* were effectively protecting stream channels, fish habitats, and riparian function, researchers assessed the condition of small fish-bearing streams (code class S4) in the central interior plateau of B.C. during 2001/02. A total of 2,989 cutblocks harvested between 1997 and 1998 in six forest districts were reviewed to identify class S4 fish streams that were within or adjacent to cutblocks. All 72 streams identified as class S4 were

assessed in the field to determine how frequently the different types of streamside harvesting practices were implemented, whether the different practices met the objectives of the riparian guidebook, and whether the different practices were affecting fish habitat. Researchers concluded that harvesting activities and silvicultural treatments are generally meeting the objectives of the *Riparian Management Area Guidebook*, and are having a low overall effect on designated S4 stream channels and their fish habitats.

In the Prince George Forest District, policy guidelines introduced in 1999 recommended retention of 50% to 75% of the natural shading, adequate short- and long-term supplies of large woody debris, and streambank root structure near class S4 streams. The guidelines also stipulate that mineral and organic fines should be prevented from reaching the stream channel. To evaluate the effectiveness of those measures, a cooperative project was initiated in May 2001.

In the Nelson Forest Region, a 10-year program monitoring climate, snow, sediment and streamflow is providing uniform, centrally located climate data for researchers who are studying management effects in the West Arm Demonstration Forest. The network consists of seven climate stations, placed from valley bottom to alpine elevation, and four streamflow and sediment monitoring sites. UBC researchers have used the data extensively to calibrate and validate the Distributed Hydrology Soil Vegetation Model (DHSVM). In another study, in collaboration with UBC, researchers are looking at the effects of forest removal on small springs on the Ringrose slope (Nelson Forest Region).

A long-term study of sediment budgets is now in its fourth year of data collection in the City of Cranbrook Community Watershed (Nelson Forest Region). In this study, researchers are examining how recent logging and road construction affect streamflow, sediment and turbidity. Three small tributaries are being monitored, one with extensive new roads and harvesting, one with old roads and logging, and an undeveloped control. Because 2001 had a record-breaking drought in the southeast corner of B.C. (which followed a moderate drought in 2000), researchers will continue monitoring in 2002, with the expectation that there will be more normal runoff conditions.

Regular assessments are required in watersheds with high fish-habitat values. Research projects are underway in the Horsefly River and tributaries (Cariboo Forest Region), where monitoring is now in its eighth year; at Russell Creek in the Tsitika River watershed (Vancouver Forest Region), which is in the first year of a three-year study; and in the Zymoetz River watershed (Prince Rupert Forest Region), where data collection is in its seventh year. In these studies, researchers are linking observations of suspended sediment to sediment sources, climatic and seasonal variables such as rainfall, snow melt, and flood events, and management activities such as road-building and deactivation.

Researchers are continuing several studies that are using paired impact and upstream control sites to examine whether harvesting is changing the morphology of harvested reaches. Preliminary results indicate that forest harvesting reduces the channel geometric complexity with the most dramatic decreases observed under the aggressive harvesting treatment.

June 1997

July 1999

Researchers in the Prince Rupert Forest Region have developed a hazard classification system for alluvial fans based on forest stand attributes and evidence of past hydrogeomorphic processes, such as floods, hyperconcentrated flows, and debris flows. In 2001/02, researchers completed fieldwork on 65 fans in the forest region to help refine descriptions for the classification system. They assessed 59 fans where forestry activities had taken place, ranging from single road construction to complete clearcutting. Ten fans were in a natural state.

Applications

At Upper Penticton Creek in the Kamloops Forest Region, researchers are developing a computer model to evaluate the effects of forest harvesting on streams over a wide range of weather and site conditions. The Upper Penticton Creek website is at http://foresthydrology.gov.bc.ca/penticton

Researchers are using the results of stream channel studies to construct a visual database to illustrate the wide range of natural variability in fluvial systems across the southern interior. Information gained from stream channel studies will allow them to compare the characteristics of natural, uninfluenced streams with streams that have undergone different forest development and restoration procedures.

In the Vancouver Forest Region, researchers at Russell Creek have concluded that the equivalent clearcut area has declined from a maximum of more than 21% in 1991 to its current level of 12%, with a corresponding decline in peak flows. This helps establish a link between equivalent clearcut area and streamflow and explains the decline in sediment yield at Russell Creek observed over the past 10 years.

Researchers from the Cariboo, Kamloops and Nelson forest regions and the Research Branch presented the results of their research at a workshop on watershed assessment in the southern interior of B.C. The proceedings synthesize knowledge over a range of topics, including watershed assessment procedures, forest effects on watershed hydrology, snowline patterns, peak flow models, sediment budgets, stream channels, and retrospective watershed studies.

In the Prince Rupert Forest Region, researchers have developed equations to predict the risk of future hydrogeomorphic events, based on measurements of watershed characteristics and events over the past 50 years. During 2001/02, they held training sessions throughout the region on the hazard classification system for forestry on fans, and gave presentations at five major provincial conferences. This information and associated training will help forest managers recognize and manage high-hazard areas.

Cooperators

B.C. Environment Youth Team (E-Team)

B.C. Ministry of Water, Air and Land Protection

City of Cranbrook

Department of Fisheries and Oceans Canada

Forest Renewal BC

Galloway Lumber Co. Ltd.

Interior Lumber Manufacturers' Association

P. Beaudry and Associates Ltd.

Riverside Forest Products Ltd.

Simon Fraser University

University of British Columbia

[2] Soil conservation

Background

The primary goal of soil conservation research and extension is to help maintain the productivity of B.C.'s soils by providing cost-effective management tools and information. The Long-Term Soil Productivity Study, now in its tenth year in B.C., is following the effects of soil compaction and organic matter removal on site productivity. The long-term nature of the study provides an opportunity to monitor the changes and recovery of the soil fauna community and other factors over the full rotation period of 80 to 120 years.

Summary

Researchers maintained and monitored existing sites in the Long-Term Soil Productivity Study in the BWBS, SBS, and ICH ecological zones and made installations in the IDF and IDF-calcareous. They also selected several new sites in the ICH zone.

One-year results for soil mesofauna and macrofauna in the SBS installations of central B.C. show that soil compaction and forest floor removal in clearcuts significantly reduced the density and diversity of soil fauna, as compared with uncut forest. Researchers also reported negative responses of aspen and white spruce to organic matter removal and soil compaction in the BWBS.

Researchers in the Cariboo Forest Region assessed rehabilitated landings, where they found that growth was almost as good as in undisturbed plantations adjacent to the landings. The slight decrease was partially due to damage by cattle grazing. If landings are carefully chosen to avoid additional disturbance, good results can be obtained with very economical rehabilitation techniques.

Applications

Researchers from the Kamloops and Nelson forest regions are part of the Results-Based Forest Practices Code Soils and Terrain Team. They have contributed to a *Harvesting Handbook* that brings together best management practices and updates provincial harvesting strategies.

Researchers promote the application of knowledge about forest soils to B.C. conditions, by working collaboratively with resource managers. Results from Long-Term Soil Productivity Study sites in the IDF zone in the East Kootenays were presented at the Columbia Mountains Institute of Applied Ecology annual meeting and field tour during 2001/02. Additional field tours were attended by faculty from the University of Calgary and the University of Alberta, faculty and students from Selkirk College in Castlegar, B.C., and representatives from the U.S. Department of Agriculture (USDA) Forest Service, B.C. Ministry of Forests and the forest industry. A Kamloops researcher presented short-term results from the Long-Term Soil Productivity Study to more than 40 participants at the 24th Annual Pacific Regional Soil Science Society Workshop.

At two training sessions in Invermere and Castlegar (Nelson Forest Region), researchers covered principles and practical experiences in soil rehabilitation, including soil disturbance guidelines and soil plasticity concepts. Some 40 to 50 planning and operations staff from government and licensee organizations attended each session.

An extension note by researchers in the Vancouver Forest Region reported on the results of a nine-year study to determine the short- and long-term impacts of hoe-forwarding on survival, growth and performance of seedlings. On sandy loam to loamy sand soils, the detrimental effects of hoe-forwarding may be minimized by controlling the trafficking pattern used during logging, and by undertaking some spot remediation with the machine, concurrent with logging.

Cooperators

Long-Term Soil Productivity Study

BC Research Inc.
Canadian Forest Service
Kalesnikoff Lumber Co. Ltd.
Michigan Technological University
Selkirk College
Tembec Industries Ltd.
USDA Forest Service
University of British Columbia
University of Northern British Columbia

Rehabilitated Landings

Forest Renewal BC
Inland Timber Management Ltd.
Lignum Ltd.

Hoe-forwarding

Foresol Consulting Ltd.

Hoe-forwarding

Hoe-forwarding was introduced to coastal B.C. in the late 1980s to reduce logging costs and avoid some of the effects experienced with other ground-based harvesting systems. Hoe-forwarding in wet soil conditions can be detrimental, leading to reduced growth and performance of Douglas-fir or other species.

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[3] Terrain stability

Background

The frequency of landslides on unstable terrain can increase after timber harvesting or road-building. Researchers have focused on ways to accurately identify sensitive sites that are prone to terrain instability, so the sites can be managed to prevent soil loss, minimize damage to streams and fish habitat, and protect forest road infrastructure.

Summary

In the southern interior of B.C., a six-year study of landslides in the Arrow and Kootenay Lake forest districts (Nelson Forest Region) is nearing completion. Researchers are comparing the landslide density in undeveloped and developed terrain. Researchers are also studying terrain stability in coastal areas in the Queen Charlotte Islands, on the west coast of Vancouver Island, and in the Coast Mountains, where different types of steep terrain (i.e., with a gradient of more than 20 degrees) can have significantly different landslide rates after logging.

The Nelson Forest Region study indicates that the landslide density in developed terrain was about six times that in undeveloped terrain. About 90% of development-related landslides are caused by roads. Other significant factors affecting landslide density were slope, terrain category, and bedrock geology.

Researchers also evaluated landslide hazards in the Cascade Mountains south of Chilliwack and Hope, and on southwestern Vancouver Island.

Applications

The results of terrain stability research in coastal B.C. were published during 2001/02 by the Vancouver Forest Region in two technical reports and one extension note. With accurate identification of high landslide hazard terrain, forest managers can either avoid the hazardous terrain entirely, or mitigate against possible landslides. The extension note reports on a study using helicopters to harvest timber (heli-logging) on steep slopes to avoid landslides. The results show that soil disturbance in heli-logged areas is reduced, as compared with grapple-yarded areas.

A researcher from the Prince George Forest Region is co-author of a book chapter that summarizes flowslide mapping techniques from various parts of the world. Sensitive sediments and associated flowslides are common in areas of glaciomarine sediment in coastal B.C., and the flowslides can travel extremely rapidly on slopes that are essentially flat. Conventional Terrain Stability Mapping does not adequately treat the hazard associated with these sediments. Some of the reported methods may be applicable in the B.C. context.

The Nelson Forest Region and the BC Forestry Continuing Studies Network presented a three-day workshop, "Terrain Stability and Forest Management in the Interior of British Columbia," in Nelson in May 2001, which was attended by more than 200 people. The workshop proceedings will be published as a technical report that synthesizes knowledge with reference to management implications.

Cooperators

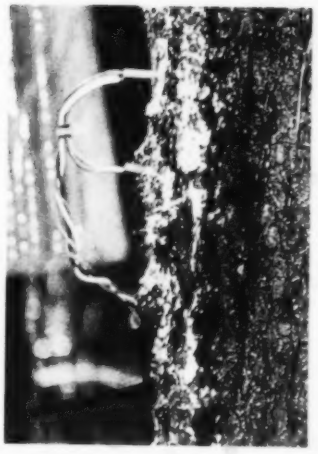
BC Forestry Continuing Studies Network

M.A. Carson, Consultant, Victoria

[4] Climatology

Background

The B.C. government is party to national and international accords to help control and reduce greenhouse gas emissions. Increasing concentration of these gases in the atmosphere may cause changes in climate, which may, in turn, alter the future sustainable use of our natural resources. Researchers are studying how forest management affects the amount of carbon dioxide in the atmosphere, and how future climate change could affect forest management.



Summary

Research Branch, the B.C. Ministry of Sustainable Resource Management, UBC, and the Canadian Forest Service are cooperating in a study at a site near Campbell River on Vancouver Island. Researchers are examining how net ecosystem productivity varies from year to year in Douglas-fir forests. The project has demonstrated that B.C.'s forests are currently a carbon sink. The information is also being used to model, at the ecosystem level, current and future carbon balances of B.C.'s forests.

Climatology is frequently included as a component of multi-disciplinary research projects. Climatic variables are important drivers of basic hydrologic processes, so understanding climate is necessary for evaluating the effectiveness of forest practices in maintaining watershed processes. Researchers from the Research Branch and the Kamloops Forest Region are working together to examine the effects of timber harvesting, including monitoring site weather conditions (and their influence on snow accumulation and melt) and the forest water balance.

Applications

Information from the carbon balance analysis is contributing to a cooperative effort with the federal government to decide how forests could be included as part of Canada's actions to support the Kyoto Protocol to reduce greenhouse gas emissions. That information is also necessary for a policy analysis of the implications of the Kyoto Protocol on the management of B.C.'s forests.

A climatologist from the Research Branch also participated in the development of a strategy and work plan for the advisory committee of the Canadian Climate Impacts and Adaptation Research Network Forest Sector Node.

Also during 2001/02, two scientists from the Research Branch summarized the results of a study on the impacts of ultraviolet-B radiation on tree seedlings.

Cooperators

B.C. Ministry of Sustainable Resource Management

Canadian Forest Service

University of British Columbia

[3] Terrain stability

Background

The frequency of landslides on unstable terrain can increase after timber harvesting or road-building. Researchers have focused on ways to accurately identify sensitive sites that are prone to terrain instability, so the sites can be managed to prevent soil loss, minimize damage to streams and fish habitat, and protect forest road infrastructure.

Summary

In the southern interior of B.C., a six-year study of landslides in the Arrow and Kootenay Lake forest districts (Nelson Forest Region) is nearing completion. Researchers are comparing the landslide density in undeveloped and developed terrain. Researchers are also studying terrain stability in coastal areas in the Queen Charlotte Islands, on the west coast of Vancouver Island, and in the Coast Mountains, where different types of steep terrain (i.e., with a gradient of more than 20 degrees) can have significantly different landslide rates after logging.

The Nelson Forest Region study indicates that the landslide density in developed terrain was about six times that in undeveloped terrain. About 90% of development-related landslides are caused by roads. Other significant factors affecting landslide density were slope, terrain category, and bedrock geology.

Researchers also evaluated landslide hazards in the Cascade Mountains south of Chilliwack and Hope, and on southwestern Vancouver Island.

Applications

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Cooperators

B.C. Ministry of Sustainable Resource Management

Canadian Forest Service

University of British Columbia

[1] Advanced generation of coastal Douglas-fir

Background

Research into the genetic improvement of Douglas-fir has progressed to the point where an advanced generation breeding population (F_2) is being established. The resulting faster-growing trees will enhance the productivity of the forest land base and provide greater flexibility in managing reforested areas, because trees reach free-growing status more quickly, and plantations have shorter rotations. Fast growth is not the only criterion for advanced-generation breeding of coastal Douglas-fir: the program also emphasizes maintaining high wood quality and growth form, maintaining high genetic diversity, and reducing inbreeding in seed orchards.

Summary

Researchers selected the best progeny from the first-generation parental crosses of Douglas-fir as parents for an advanced-generation breeding population. They placed selected parents into 30 unrelated breeding groups (30 sub-lines) to produce progeny that will potentially exhibit fast growth and other desirable traits (e.g., wood density and growth form). Controlled crosses in eight sub-lines have been completed, and seedlings are ready to be tested in the field. The seedlings from the eight sub-lines will be used to establish at least six progeny test sites.

Applications

Researchers will select the most desirable offspring from each sub-line as the source for scions, which will be used to propagate superior parents in advanced-generation seed orchards. Selecting the best trees from the best families will ensure that the eventual parents growing in the seed orchard will possess high genetic quality and diversity.

[2] Provenance tests of coastal broadleaf species

Background

Interest in broadleaf species has increased steadily because of their wood quality and their function as keystone species in ecosystems, helping maintain species and genetic diversity at the landscape level. Provenance research is focusing on red alder, bigleaf maple, and black cottonwood.

Summary

Researchers started provenance tests of coastal broadleaf species in the early 1990s when interest in broadleaf management was at its peak. Red alder and bigleaf maple were chosen as target species largely because of their high-quality wood for value-added products. The interest in black cottonwood comes from its potential for short-rotation, high-yield clonal forestry. However, the effective use and conservation of these species are severely hampered by a lack of basic genecological knowledge (genecology is the study of genetic variation within a species in relation to changes in the environment).

The core of the coastal broadleaf provenance research is short-term common-garden testing. Researchers are focusing on the genetic variability of frost hardiness, vegetative cycles, growth, and pest incidence within the natural range of the species. This genecological information forms the framework for the conservation and protection of genetic diversity by regulating the transfer of seeds within adaptive zones.

Researchers have completed common-garden testing of red alder and bigleaf maple, both of which are fast-growing species. Some selected provenances can sustain 1-metre annual elongation at productive sites. Despite its "fame" as a weed species, red alder is sensitive to the site environment. At an exposed site on the north coast of B.C., provenances from Vancouver Island and the south coast suffered cold injury and mortality, some as high as 100%. Black cottonwood is the most variable species of the three, and it is the focus of current testing. Data analysis will address the pattern of geographic variation, the natural hybridization of black cottonwood with closely related balsam poplars, and the potential responses of black cottonwood to climate change.

Short-term common-garden testing is supported by limited long-term provenance testing. The objective of the long-term tests is to assess the growth potential and stem quality of trees in managed plantations. These plantations are being established in climatic areas that are most favourable for the growth of each species.

Applications
Results for common-garden tests of red alder and bigleaf maple have been incorporated into seed transfer guidelines. Results from long-term provenance trials will help define the areas where broadleaf species are expected to have the best commercial potential.

Cooperators

Forest Renewal BC

[3] Somatic embryogenesis

Background
For centuries, vegetative propagation of trees and most agricultural crop plants has been used to produce exact copies of individuals with desirable traits. Somatic embryogenesis is a relatively new form of vegetative propagation, in which embryos are removed from seeds and grown in a nutrient culture that favours their multiplication. Individual embryos are transferred later to containers and grown to produce emblings (i.e., seedlings produced through somatic embryogenesis). Somatic embryogenesis has two advantages over most other forms of vegetative propagation: unlimited numbers of elite individuals can be produced rapidly, and embryos of selected individuals can be frozen. Exact, preserved copies can be retrieved from storage and multiplied without encountering the problems that plague other forms of vegetative propagation, such as maturation (inability to produce young dividing tissue from mature tissue) or plagiotropism (tendency to grow horizontally rather than vertically).

Summary
In 1992, the ministry and industry began a series of field tests of interior spruce to examine the growth and weevil resistance of emblings versus conventional

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Summary
In 1992, the ministry and industry began a series of field tests of interior spruce to examine the growth and weevil resistance of emblings versus conventional

seedlings. Other objectives were to determine a breeding strategy to achieve the best growth and weevil resistance of spruce, and to estimate the potential genetic gain if somatic embryogensis was adopted in the provincial reforestation programs in B.C.

Researchers established 14 field test sites to compare the performance of emblings and seedlings as stock types. These tests included emblings from 770 individual lines from 35 full-sibling families in the Prince George Forest Region between 1994 and 1998. At seven years, after accounting for differences in initial heights of seedlings versus emblings, the height growth potential of the emblings did not differ significantly from that of the seedlings. Researchers are analyzing height data to determine the potential growth gains when the best individuals or families are selected and deployed as emblings. Researchers will assess weevil damage as it occurs in the next few years.

Applications

If researchers can identify weevil-resistant individual embling lines, they may be able to select and deploy emblings that are fast-growing and weevil resistant. The adoption of somatic embryogenesis clonal testing into the breeding program could result in substantial improvements in genetic testing approaches in spruce, and a new type of planting stock in spruce, if it can be produced economically.

Cooperators

Cellfor Inc.

University of Northern British Columbia

[4] Resistance to white pine weevil in interior spruce

Background

The white pine weevil is one of the most damaging pests of young spruce in western North America. It can significantly reduce volume growth and cause crooks and forks that can reduce log value or render trees unmerchantable. Identifying and deploying resistant genotypes may offer a possible solution to the weevil problem.

Summary

In a preliminary screening project, the ministry planted 3,150 seedlings from 42 controlled crosses among supposedly resistant and susceptible parents at the Kalamalka Forestry Centre in 1995. The test trees were obtained from the Prince George interior spruce breeding program and included crosses that were resistant x resistant, resistant x susceptible, and susceptible x susceptible. In summer 1999, about 14,000 weevils were raised at the Pacific Forestry Centre. The weevils were applied three per tree in the fall to ensure uniform opportunity for weevil attack throughout the plantation. Researchers assessed the rate of weevil attack in 2000 by determining the extent of feeding and egg deposition, enumerating tree-leader kill, and examining microscopic slides of cross-sections of branches and resin canals. The resistant x resistant crosses had the lowest weevil attack rate and the largest and most numerous resin canals. The susceptible x susceptible crosses had the highest attack rate and the fewest resin canals. The resistant x susceptible crosses were intermediate in attack rate and resin canal number and size.

Applications

These results corroborate earlier evidence of genetic variation and high heritability for weevil resistance, indicating that it is feasible to genetically select for that trait. The results also suggest that resin canal size and density may be a mechanism for measuring weevil resistance. This project helped identify weevil-resistant parents that were included in a weevil-resistant interior spruce seed orchard at the Vernon Seed Orchard Company. Seeds will be planted in the Prince George Seed Planning Zone when it becomes available (about 2010).

Cooperators

Canadian Forest Service

Vernon Seed Orchard Company (cooperative companies: Weldwood of Canada Ltd., The Pas Lumber Co. Ltd., West Fraser Products Ltd.)

The Forest Science Program provides an infrastructure of support services so that research can be conducted to a high and consistent standard. Those services include staff specialists who can advise on research design and data analysis, project planning, data management, and extension of research results. Staff in the Research Laboratory advise scientists on appropriate analytical techniques to meet project objectives, and they conduct analyses of soil, water and vegetation samples.

Two research stations, at Kalamalka and Cowichan Lake, primarily serve the forest genetics activity. These provide greenhouse and outplanting facilities for conducting genetics research, and staff support services for propagating stock and tending plantings. The research stations also house clone-banks of parent trees and offspring of selected breeding stock. Because he research station activities are so closely related to projects reported under the forest genetics activity, they are not covered further in this section.

The B.C. Ministry of Forests also maintains a library that serves the Forest Sciences Program as one of its primary clients.

[1] Biometrics

Background

Staff in the Biometrics Unit provide advice and consultation to research scientists and other ministry staff on statistical procedures to meet research and operational needs, and for forest policy development. Topics include experimental design, sampling theory, and a broad range of statistical analyses.

Although all scientists in the Forest Science Program are well-versed in the principles of biometrics, the advanced level of theory required for unique situations encountered in conducting research on natural resources requires specialized assistance. Biometricians within the program are usually abreast with the latest developments in their field, and they also conduct their own projects to develop new adaptations of analytical theory to forest management issues.

Summary

The primary focus of the Biometrics Unit was responding to requests from executive, management and staff throughout the ministry on the use of statistical methods in strategic planning and research. This work included:

- modelling support for the Coastal Revitalization Project,

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Summary
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- modelling support for the Coastal Revitalization Project,

- analytical support for the ongoing Timber Supply Review and for projects in the Policy and Economics Division,
- statistical advice to Revenue Branch and several external agencies, including the B.C. Ministry of Water, Land and Air Protection, the B.C. Ministry of Sustainable Resource Management, and the Long Beach Model Forest,
- ongoing participation in a project for the Vancouver Forest Region Coarse Woody Debris Working Group on the effectiveness of using a modified operational cruise to determine the total volume of downed wood in a stand,
- collaboration with the Ecology and Earth Sciences sections on the development of a Bayesian estimator for future use in the Site Index Biogeoclimatic Ecosystem Classification (SIBEC) project, and
- collaboration with Forest Practices Branch in reviewing a results-based code pilot proposal, and on assessing the effectiveness of survey methods for the British Columbia Wildlife Tree Evaluation Project.

As in previous years, the Biometrics Unit continued to provide advice to researchers in all phases of their projects, from design through to approval for publication.

Applications

Staff in the Biometrics Unit are actively involved in extension and in developing biometrics applications. They organized and presented a special session, "Statistics in Forestry," at the Statistical Society of Canada meeting at Simon Fraser University this year. They also continued extension work with the Statistical Analysis System, a software package frequently used in research projects, by maintaining an online bulletin board and establishing a discussion distribution list, through which practitioners can obtain information and share problems and solutions.

In collaboration with regional researchers, biometrics staff completed a project on the use, by winter wrens, of small coastal streams and forest gaps as breeding habitats. The report, which will be published in 2002 in the journal *Northwest Science*, focuses on the innovative project design and sampling methods required to assess relative habitat use.

Also during 2001/02, biometrics staff published a Land Management report (LMH 50) on a simulation study of the survey methods used to determine if a site has been adequately reforested. The study assessed risk of error as a function of the many parameters of the current silvicultural free-growing survey. The report uses decision curves to show how changes to the survey parameters of minimum inter-tree distance, minimum stocking standard, target stocking standard, maximum plot count, and sample size change the chance of correctly determining whether cutblocks have successfully reached free-growing.

[2] Communications and extension

Background

Communications and extension services are designed to foster the incorporation of new knowledge and research results into ministry policies, planning, and

management practices, and to increase the awareness of the Forest Science Program's products and activities.

Summary

Websites

The Forest Science Program maintains a number of websites that provide access to program products and details about their applications to forest management. The Research Branch and each regional component of the program maintain websites that are relevant to their specific work. During 2001/02, these websites were linked through a central Forest Science Program portal (www.for.gov.bc.ca/forsci). On the main site, a listserv link was established as well, so visitors can now self-subscribe to receive notice of new publications, products, and upcoming events.

The Research Branch site was expanded and updated this year to include a project index, a keyword search function, a branch staff list, new topic summaries, and a publications list.

Extension

Extension activities during 2001/02 continued to include consultation services to district and regional staff, publication of technical reports and extension notes, and delivery of training initiatives and workshops. Because most extension activities are mentioned in relation to individual research projects elsewhere in this report, only a few additional highlights are included here.

The Vancouver Forest Region became a member of the Forest Research Extension Partnership (FORREX) (formerly known as the Southern Interior Forest Extension and Research Partnership) this year, and a representative of the region sits on the FORREX board of directors. This cooperative organization was renamed after expanding to cover the coastal area defined by the Vancouver Forest Region boundary. By joining FORREX, the regional researchers are able to

take advantage of the technical support provided by the partnership, and to align their extension activities with those in the southern interior.

Cariboo Forest Region researchers formed a partnership with the B.C. Ministry of Sustainable Resource Management, the B.C. Ministry of Water, Land and Air Protection, and several forest licensees in 2001/02 to help incorporate research concepts and results into activities such as land-use planning and alternative harvesting methods.

Applications
The most important aspect of websites lies in their volume of traffic, and that continues to grow for all of the Forest Science Program component sites. The Vancouver Forest Region site, for example, had an average of 125 visits per day between April 1 and December 31, 2001. Publications were downloaded a total of 3,452 times during that period.

The effectiveness of extension is best measured by client satisfaction, and the program continues to receive positive user feedback from forest companies and other resource interests, including some from out-of-province.

[3] Information management

Background
Staff in information management help develop management tools for the succession of information and to maintain the continuity of research data over the long term. By transferring knowledge, via a well-designed knowledge management system, we can ensure that the best information is available to resource decision-makers.

Summary
One of the central tools being developed by the Information Management Unit is a searchable cataloguing system that links people with products and research projects. This system fulfills the ministry's corporate responsibility to house the information, and it helps integrate Forest Science Program data with other data in the public domain. The system collates information that has been collected about each researcher and technician's involvement with past and present research projects, and accounts for all products (e.g., data, publications and reports) derived from these projects.

In 2001/02, Information Management staff collaborated with the ministry library to integrate the library's publications catalogue into the Forest Science Program cataloguing system. All Forest Renewal BC projects were catalogued, and, with the help of FORREX, were made available on the Internet through the Natural Resources Information Network (NRIN), at http://nrin.siferp.org

Cooperators

Forest Research Extension Partnership (FORREX) (formerly the Southern Interior Forest Extension and Research Partnership)

Applications
A public-access website was developed in conjunction with FORREX to search the Forest Science Program catalogue through NRIN. This is a key step to providing quick and efficient access to science-based information for making policy and resource management decisions.

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[4] Research laboratory

Background

The research laboratory provides accurate, specialized analytical services to support the research activities of Research Branch and regional scientists. Based on the recommendations of a review in 1999, the laboratory is increasing its cost-recovery levels for internal Ministry of Forests clients. Where possible, the laboratory is also extending its services to other public-sector collaborators at full cost-recovery levels to help with revenues and to maintain optimum operating efficiency. These changes are being phased-in gradually to allow project managers to accommodate the new costs in their project planning.

Summary

Each year, laboratory scientists analyze thousands of samples and refine and develop chemical analysis methods. During 2001/02, the laboratory responded to 155 requisitions for the analysis of 11,015 samples. The samples consisted of 47% plant tissues, 35% soils, and 18% miscellaneous materials. Sample analysis resulted in 159,480 individual tests, 97% of which were for chemical properties, and 3% for physical properties.

The laboratory is broadening its economic base through active promotion of laboratory services to clients beyond the Forest Science Program. The results of this limited marketing to universities and other external clients is helping the laboratory exceed cost-recovery targets.

Applications

The research laboratory continues to provide cost-effective analytical services to Ministry of Forests researchers and external clients. It also maintains archives that are essential for validating the results of resource management research.

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April 1, 2001 to March 31, 2002

By major discipline and subactivity

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The BEC terms used in this publication are defined below. A complete listing of all BEC terms is available at www.for.gov.bc.ca/research/becmaps/becappen.txt

BG	Bunchgrass	
BWBS	Boreal White and Black Spruce	
ESSF	Engelmann Spruce–Subalpine Fir	
ICH	Interior Cedar–Hemlock	
	ICHmw	Moist Warm ICH
	ICHmw2	Columbia-Shuswap Variant ICHmw
	ICHmw3	Thompson Variant ICHmw
	ICHvk1	Mica Variant ICHvk
IDF	Interior Douglas-fir	
	IDFdk	Dry Cool IDF
	IDFdk1	Thompson Variant IDFdk
	IDFdk2	Cascade Variant IDFdk
	IDFdk3	Fraser Variant IDFdk
	IDFxm	Very Dry Warm IDF
MS	Montane Spruce	
	MSxk	Very Dry Cool MS
SBPS	Sub-boreal Pine–Spruce	
	SBPSdc	Dry Cold SBPS
	SBPSxc	Very Dry Cold SBPS
SBS	Sub-boreal Spruce	
	SBSdw	Dry Warm SBS
	SBSdw2	Blackwater Variant SBSdw
	SBSmw	Moist Warm SBS

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We welcome your comments and questions about the Forest Science Program at the Ministry of Forests, and invite you to contact us at the following locations:

Research Branch Headquarters

Location
712 Yates Street
Victoria, BC V8W 1L4
Phone 250 387-6721 Fax 250 387-0046
www.for.gov.bc.ca/research
Mailing address
PO Box 9519 Stn Prov Govt
Victoria, BC V8W 9C2

Research Stations (as of Dec. 2002)

Research Laboratory
Location
4300 North Road
Victoria, BC V8Z 5J3
Phone 250 952-4136 Fax 250 952-4119
Mailing address
PO Box 9536 Stn Prov Govt
Victoria, BC V8W 9C4
Cowichan Lake Research Station
Box 335, 7060 Forestry Road
Mesachie Lake, BC V0R 2N0
Phone 250 749-6811 Fax 250 749-6020
Kalamalka Forestry Centre
3401 Reservoir Road
Vernon, BC V1B 2C7
Phone 250 260-4755 Fax 250 542-2230

Regional Forest Science Offices (as of Dec. 2002)

Cariboo Forest Region
200 - 640 Borland Street
Williams Lake, BC V2G 4T1
Phone 250 398-4345 Fax 250 398-4380
www.for.gov.bc.ca/cariboo/research/research.htm

Kamloops Forest Region
515 Columbia Street
Kamloops, BC V2C 2T7
Phone 250 828-4131 Fax 250 828-4154
www.for.gov.bc.ca/research/kamloops/index.htm
Nelson Forest Region
518 Lake Street
Nelson, BC V1L 4C6
Phone 250 354-6200 Fax 250 354-6250
www.for.gov.bc.ca/nelson/nel_r.htm
Prince George Forest Region
1011 4th Avenue
Prince George, BC V2L 3H9
Phone 250 565-6100 Fax 250 565-4349
www.for.gov.bc.ca/pgeorge/pgeo_r.htm
Prince Rupert Forest Region
Bag 5000, 3726 Alfred Avenue
Smithers, BC V0J 2N0
Phone 250 847-7500 Fax 250 847-7217
www.for.gov.bc.ca/prupert/research/index.htm
Vancouver Forest Region
2100 Labieux Road
Nanaimo, BC V9T 6E9
Phone 250 751-7001 Fax 250 751-7190
www.for.gov.bc.ca/vancouvr/research/research_index.htm

End Notes

1 For the BEC term definitions used in this report, see the "Biogeoclimatic Ecostystem Classification Definitions" section on page 53.

2 "Extension Notes" are published by Forest Science Program sections in individual forest regions and by the Research Branch in Victoria. All use an ascending numbering system, so there may be, for instance, an Extension Note 30 from more than one source. To find a particular reference, refer to the region or branch specified in the citation.

Managing Editor for the Annual Report:
Carole L. Leadem, Research Branch

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